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Science & Technology

***USSR: Physics &
Mathematics***

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SCIENCE & TECHNOLOGY

USSR: PHYSICS & MATHEMATICS

CONTENTS

ACOUSTICS

- Nonlinear Reflection of Sound Wave in Gas Mixture
 (A. M. Dykhne, S. V. Pokrovskiy; ZHURNAL EKSPERIMENTALNOY I
 TEORETICHESKOY FIZIKI, No 1, Jan 87)..... 1

CRYSTALS, LASER GLASSES AND SEMICONDUCTORS

- Use of Lasers With $F_A(II)$ -Color Center KCl:Li Crystals in the
 Intracavity Laser Spectroscopy Method
 (V. M. Bayev, V. P. Dubov, et al.; KVANTOVAYA
 ELEKTRONIKA, No 8, Aug 86)..... 2
- Microwave Conductance of Oxygen-Bearing Silicon and Inverted
 EPR-Signal From New Centers
 (V. M. Babich, N. P. Baran, et al.; PISMA V ZHURNAL
 EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 11, Dec 86).... 3
- Observation of Instabilities in Time During Dynamic Self-
 Diffraction of Light in Anisotropic Nonhomogeneous Medium
 (R. B. Alaverdyan, S. M. Arakelyan, et al.; PISMA V
 ZHURNAL TEKHNIЧЕСКОY FIZIKI, No 2, 26 Jan 87)..... 4
- Directional Stimulated Radiation Emission by Hot Ge Holes
 (A. V. Muravyev, Yu. N. Nozdrin, et al.; PISMA V
 ZHURNAL TEKHNIЧЕСКОY FIZIKI, No 2, 26 Jan 87)..... 4
- Photoinduced Low-Temperature Changes in Optical Losses in
 Fiber Optics Based on Chalcogenide Glasses
 (V. G. Borisevich, G. G. Devyatykh, et al.; PISMA V
 ZHURNAL TEKHNIЧЕСКОY FIZIKI, No 1, 12 Jan 87)..... 5

Population Inversion in Gapless Semiconductors as Result of Interband Pumping (G. M. Genkin, A. V. Okomelkov, et al.; PISMA V ZHURNAL TEKHNIЧЕСКОY FIZIKI, No 1, 12 Jan 87).....	6
Electron-Paramagnetic Resonance in Doped EuO (M. I. Auslender and N. A. Viglin; ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 1, Jan 87).....	6
Discovery of New Ag Modification in InSb(110)+Ag System (V. Yu. Aristov, I. L. Bolotin, et al.; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 1, 10 Jan 87)..	7
Is $Al_{86}Mn_{14}$ A Quasi-Crystal or a Cubic Crystal? (V. Ye. Dmitriyenko; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 1, 10 Jan 87).....	8

FLUID DYNAMICS

Rotation of Magnetized Particle in Electrically Conducting Viscous Medium (B. M. Berkovskiy, B. E. Kashevskiy, et al.; MAGNITNAYA GIDRODINAMIKA, No 4, Oct-Dec 86).....	9
New Equilibrium Forms of Free Surface of Confined Magnetic Fluid (V. M. Berkovskiy, V. G. Bashtovoy, et al.; MAGNITNAYA GIDRODINAMIKA, No 4, Oct-Dec 86).....	10
Method of Two-Time Green Functions in Molecular Hydrodynamics of Superfluid Liquid (Yu. A. Tserkovnikov; TEORETICHESKAYA I MATEMATICHESKAYA FIZIKA, No 3, Dec 86).....	11
Far Field of Steady Waves Produced by Local Perturbation Sources in Stream of Stratified Fluid (V. F. Sannikov; PRIKLADNAYA MATEMATIKA I MEKHANIKA, No 6, Nov-Dec 86).....	11
Method of Calculations for Flow of Ideal Gas Through Plane and Axisymmetric Nozzles With Broken-Line Contour (A. N. Krayko, N. I. Tillyayeva, et al.; ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI, No 11, Nov 86).....	12

LASERS

Effect of Optical Inhomogeneities on Space Coherence of Radiation Emitted by Laser With Unstable Resonator (L. A. Danilova, D. I. Staselko, et al.; OPTIKA I SPEKTROSKOPIYA, No 6, Dec 86).....	13
--	----

Production-Process CO ₂ Laser With Amplified Pulse-Repetition Operation (A. M. Belenkiy, V. V. Vasil'tsov, et al.; KVANTOVAYA ELEKTRONIKA, No 8, Aug 86).....	14
Super-Short Yttrium Aluminate Pulse Generator With Controlled Resonator Q-Factor (A. M. Valshin, V. M. Gordiyenko, et al.; KVANTOVAYA ELEKTRONIKA, No 8, Aug 86).....	14
Periodically Pulsed Excimer 'Master Oscillator - Regenerative Amplifier' Laser Set (V. P. Ageyev, V. V. Atezhev, et al.; PISMA V ZHURNAL TEKHNIЧЕСКОY FIZIKI, No 1, 12 Jan 87).....	15
Observing Effect of Laser Radiation on Low-Frequency Raman Scattering of Light (K. V. Grechushkin, A. V. Pivovarov; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 1, 10 Jan 87).....	16

NUCLEAR PHYSICS

Relaxation of Muon Polarization in Muonium With Quadrupole Interaction (V. G. Baryshevskiy, S. A. Kuten, et al.; IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA, No 12, Dec 86)....	17
Formation of Induction and Echo Signals in Angular Distribution of γ -Radiation From Oriented Nuclei (L. N. Shakhmuratova; IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA, No 12, Dec 86).....	18
C-Even Charmonium as Tool for Studying Polarization of Gluons (A. V. Batunin, S. R. Slabospitskiy; YADERNAYA FIZIKA, No 6(12), Dec 86).....	18
Transition From Current Quarks to Constituent Quarks and Properties of Toponium (A. A. Bykov, I. M. Dremin; YADERNAY FIZIKA, No 6(12), Dec 86).....	19
Contribution of Weak Neutral Z ⁰ -Current to Amplitude of Elastic Lepton Scattering in Magnetic Field (V. Yu. Linkov, I. A. Obukhov, et al.; YADERNAYA FIZIKA, No 6(12), Dec 86).....	19
Peculiarities of Inclusive Proton Spectra and Their Relation to Interaction Dynamics of High-Energy Heavy Ions (V. N. Russkikh; YADERNAYA FIZIKA, No 6(12), Dec 86).....	20

New Form of Radioactivity (G. A. Pik-Pichak; YADERNAYA FIZIKA, No 6(12), Dec 86).....	21
Experimental Determination of Duration of Fission Reaction Involving Nuclei $^{22}\text{Ne} + ^{238}\text{U}$ (V. N. Bugrov, V. G. Vinogradov, et al.; YADERNAYA FIZIKA, No 6(12), Dec 86).....	22
Elastic Scattering ^3He Ions by Carbon Isotopes (N. S. Zelenskaya, A. K. Morzabayev; IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA, No 9, Sep 86).....	22
Decay of ^{158}Tb and Possibility of More Precisely Determining Mass of Electron Neutrino (V. M. Gorozhankin, V. B. Brudanin, et al.; IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA, No 9, Sep 86).....	23
Does the Tetraneutron Exist? (R. Ya. Kezerashvili; YADERNAYA FIZIKA, No 3(9), Sep 86)...	24
Theoretical Basis for Search for Higgs Boson in γ -Meson Decay (M. I. Vysotskiy, A. S. Losev; YADERNAYA FIZIKA, No 3(9), Sep 86).....	24
Neutrino Electromagnetic Characteristics and Possible Semiannual Variation Cycle in Neutrino Flux From Sun (M. B. Voloshin, M. I. Vysotskiy, et al.; YADERNAYA FIZIKA, No 3(9), Sep 86).....	25
Search for Decays of Charmed Particles in Neutrino Experiment With Nuclear Photoemulsions Located in Fermilab 15-Foot Bubble Chamber (R. Ammar, V. V. Ammosov, et al.; YADERNAYA FIZIKA, No 3(9), Sep 86).....	25
Relativistic Effects in Production of Higgs Boson in Radiative Decay of Quarkonium (I. G. Aznauryan, S. G. Grigoryan, et al.; YADERNAYA FIZIKA, No 1, Jan 87).....	27
Hartree-Fock Description of Deformed Thulium Isotopes (A. Ye. Barzakh, V. Ye. Starodubskiy; YADERNAYA FIZIKA, No 1, Jan 87).....	27
Relativistic Correction to Three-Nucleon Binding Energy (F. M. Lev; YADERNAYA FIZIKA, No 1, Jan 87).....	28
Quadrupole Collective Motion: Old and New Approaches to Description of Experiment (O. K. Vorov, V. G. Zelevinskiy; IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA, No 1, Jan 87).....	28

Singularities in Quadratic Feynman Diagrams for Various Mechanisms of Nuclear Reactions (L. D. Blokhintsev, Kh. D. Razikov, et al.; IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA, No 1, Jan 87).....	29
States of ^{149}Eu Excited During Decay ^{149}Gd (I. Adam, Zh. T. Zhelev, et al.; IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA, No 1, Jan 87).....	30
Solitons in Coupled Electronic-Nuclear Magnetic System of Antiferromagnetic CsMnF_3 (S. A. Govorkov and V. A. Tulin; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 1, 10 Jan 87)...	30

OPTICS AND SPECTROSCOPY

Theory of Interference-Type Band Reflectors (Yu. N. Markov; OPTIKA I SPEKTROSKOPIYA, No 6, Dec 86).....	32
Synthesis of Images of Objects Viewed Through Randomly Nonhomogeneous Medium by Method of Active Interferometry (Yu. A. Zimin, A. L. Volpov; OPTIKA I SPEKTROSKOPIYA, No 6, Dec 86).....	32
Nonuniformity of Electromagnetic Field at $\gamma = 10.6 \mu\text{m}$ Wavelength Inside Atmospheric Aerosol Particles (N. N. Belov; OPTIKA I SPEKTROSKOPIYA, No 6, Dec 86).....	33
New Description of Lau Effect Based on Theory of Raster Image Forming Process (M. V. Shovgenyuk; OPTIKA I SPEKTROSKOPIYA, No 6, Dec 86)...	34
Selection of Holographic Screen for Projection of Images Reconstructed by Multiaspect Holograms of Focused Images (A. D. Galpern, A. A. Paramonov; OPTIKA I SPEKTROSKOPIYA, No 6, Dec 86).....	34
Effect of Random Inhomogeneities in Optical Fiber on Null Shift in Ring Interferometer (S. M. Kozel, V. N. Listvin, et al.; OPTIKA I SPEKTROSKOPIYA, No 6, Dec 86).....	35
Photophysical Processes and Intramolecular Charge Transfer in Molecules of Mesonitroporphyrins (S. S. Dvornikov, T. F. Kachura, et al.; OPTIKA I SPEKTROSKOPIYA, No 6, Dec 86).....	35
Electroluminescence of Dielectrics in Far Off-Equilibrium Charged State (V. L. Uvarov, B. I. Moiseyenko, et al.; OPTIKA I SPEKTROSKOPIYA, No 6, Dec 86).....	36

Effect of Frequency Exchange on Signal in Transient Active Spectroscopy (D. V. Kolomoitsev, S. Yu. Nikishin; OPTIKA I SPEKTROSKOPIYA, No 6, Dec 86).....	37
Sharpening Contrast in Multibeam Interference Devices (A. A. Yelisseyev, O. M. Ravodin, et al.; IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA, No 12, Dec 86).....	38
Parametric and Resonance Interaction of Ultrashort Light Pulses in Nonlinear Multilevel Medium (A. A. Zabolotskiy; ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 1, Jan 87).....	38

PLASMA PHYSICS

State Parameters of Pulse-Discharge Plasma in Xenon-Filled Closed Tube (V. Ye. Gavrilov; OPTIKA I SPEKTROSKOPIYA, No 6, Dec 86)....	39
Instability of Bounded Electron Beam in Longitudinal Magnetic Field (A. N. Mosiyuk; FIZIKA PLAZMY; No 1, Jan 87).....	40
Effect of Plasma Rotation in Tokamak on Stabilizing Action of Electrically Conducting Wall (L. Ye. Zakharov, S. V. Putvinskiy; FIZIKA PLAZMY, No 1, Jan 87).....	40
Effect of Plasma Resonance on Properties of Surface Waves (M. I. Bakunov, V. D. Pikulin, et al.; FIZIKA PLAZMY, No 1, Jan 87).....	41
Confinement of Energy in Tokamak-10 Plasma During Electron-Cyclotron-Resonance Heating (V. V. Alikayev, A. A. Bagdasarov, et al.; FIZIKA PLAZMY, No 1, Jan 87).....	41
Low-Frequency Oscillations in Nonideal Plasma (M. A. Berkovskiy, A. A. Valuyev, et al.; PISMA V ZHURNAL TEKHNIЧЕСКОY FIZIKI, No 2, 26 Jan 87).....	42
Self-Alignment of Ions Drifting in Plasma (S. A. Kazantsev, A. G. Petrashen, et al.; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 1, 10 Jan 87).....	43

TECHNICAL PHYSICS

Nuclear Orientation and Mössbauer Effect at Infralow Temperatures (V. A. Andrianov, M. G. Kozin, et al.; IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA, No 12, Dec 86).....	44
--	----

Study of Structural Defects in Ferromagnetic Metals by Method of Muon Spin Rotation (V. P. Melnichuk, V. Yu. Miloserdin, et al.; IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA, No 12, Dec 86).....	45
Transition to Combustion of Condensed Substance under Impinging Pulse of Luminous Radiation Flux (S. I. Baklan, V. N. Vilyunov, et al.; FIZIKA GORENIYA I VZRYVA, No 6, Nov-Dec 86).....	45
Dependence of Acoustical Characteristics of Laser-Induced Breakdown in Dielectric Materials on Shape of Inelastic Region (A. Yu. Ivanov, E. A. Manykin; IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA, No 11, Nov 86).....	46
Electron Structure and Optical Spectra of Heavy Alkali Metals Under High Pressure (I. I. Mazin, Ye. G. Maksimov, et al.; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 11, 10 Dec 86).....	47
Rydberg Atom on Surface of Liquid Helium (P. B. Lerner, I. M. Sokolov; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 11, 10 Dec 86).	47
Development of Crack Under Periodically Pulsed Laser Radiation (G. Ya. Glauberman, S. V. Kondrashov, et al.; ZHURNAL PRIKADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI, No 6(160), Nov-Dec 86).....	48
Experimental Observation of Photoresonance of Electrons Localized Above Surface of Solid Hydrogen (V. V. Zavyalov, I. I. Smolyaninov; ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 1, Jan 87).....	49
Anomalies in Electromagnetic Absorption of Circularly Polarized Ultrasonic Waves by Tungsten Within Doppler-Shifted Cyclotron Resonance Range (V. V. Gudkov, I. V. Zhevstovskikh; ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 1, Jan 87).....	50
Equivalence Principle and Zero-Point Field Fluctuations (L. P. Grishchuk, Ya. B. Zeldovich, et al.; ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 1, Jan 87).....	51
Studies of Tunneling in Metals Under High Pressure (V. M. Svistunov, M. A. Belogolovskiy, et al.; USPEKHI FIZICHESKIKH NAUK, No 1, Jan 87).....	51

THEORETICAL PHYSICS

Model of Earlier Stage of Universe's Evolution (K. A. Bronnikov, V. N. Melnikov; IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA, No 11, Nov 86).....	53
Evolution of Perturbations in Expanding Universe (A. A. Kofman, V. F. Mukhanov; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 11, 10 Dec 86).	54
Gravitational Interaction of Massless Fields With Higher Spins ($s > 2$) (M. A. Vasilyev, Ye. S. Fradkin; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 11, 10 Dec 86).....	54
Quantum Model of Technicolor With Compound Gauge Bosons (Yu. V. Novozhilov; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 11, 10 Dec 86).....	55
Inclusive Spectra of Secondary Particles Produced at Nuclear Targets According to Quark-Gluon String Model and Their Sensitivity to Production Mechanism (Yu. M. Shabelskiy; YADERNAYA FIZIKA, No 1, Jan 87).....	55
Interaction of Solitons in Skyrme Model (S. V. Zenkin, V. B. Kopelovich, et al.; YADERNAYA FIZIKA, No 1, Jan 87).....	56
Possible Nonweak Neutrino-Neutrino Interactions (L. B. Okun; YADERNAYA FIZIKA, No 1, Jan 87).....	57
Difficulties in Interpretation of Underground Muons From Cygnus X-3 (V. S. Berezinskiy, B. L. Ioffe, et al.; YADERNAYA FIZIKA, No 1, Jan 87).....	57
Transverse-Momentum Distributions and Azimuthal Correlations in Inclusive K^+p -Reactions at 32 GeV/s (A. G. Tomaradze, U. A. Uvarov, et al.; YADERNAYA FIZIKA, No 1, Jan 87).....	58
Jet-Like Structure of K^-p and $\bar{p}p$ Interactions at 32 GeV/s (V. V. Badintsev, V. A. Bumazhnov, et al.; YADERNAYA FIZIKA, No 1, Jan 87).....	59
Dynamics of Ion Storage Processes in Electron Beams and Rings (E. A. Perelshteyn, G. D. Shirkov; FIZIKA ELEMENTARNYKH CHASTITS I ATOMNOGO YADRA, No 1, Jan-Feb 87).....	60
Gluon Jets in Hadron-Hadron Processes and Confinement Effect (I. M. Dremin; FIZIKA ELEMENTARNYKH CHASTITS I ATOMNOGO YADRA, No 1, Jan-Feb 87).....	61

Calculation of Mass of Nucleons in Various Generations According to Theory of Gauge Fields (A. N. Kushnirenko; IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA, No 12, Dec 86).....	62
Radiation From Electrons in Synchrotron With Rectilinear Gaps (M. M. Nikitin, N. I. Fedosov; IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA, No 12, Dec 86).....	62
Topologically Nontrivial Loop Monopoles (I. A. Ovidko; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 1, 10 Jan 87).....	63
ALGORITHMS AND NUMERICAL METHODS	
Steady Spread of Tree-Top Upper-Tier Forest Fires (A. M. Grishin, V. G. Zverev, et al.; FIZIKA GORENIYA I VZRYVA, No 6, Nov-Dec 86).....	64
Solving Linear Problem of Fast Response by Numerical Methods (M. V. Orlov; VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 15: VYCHISLITELNAYA MATEMATIKA I KIBERNETIKA, No 4, Oct-Dec 86).....	65
Methods of Topology in Combinatorial Problems (S. A. Bogatyy; USPEKHI MATEMATICHESKIKH NAUK, No 6(252), Nov-Dec 86).....	65
Some Universal Constraints on Algorithms of Classification (K. V. Rudakov; ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI, No 11, Nov 86).....	66
Adaptation in Structural Pattern Recognition (A. S. Dzyuba, V. I. Mishkin; ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI, No 11, Nov 86).....	66
Mathematical Models and Computer Experiment for Problems of Function-Signal Reconstruction From Finite Set of Data (Yu. A. Belov, V. S. Kasyanyuk; ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI, No 11, Nov 86).....	67

/5915

ACOUSTICS

NONLINEAR REFLECTION OF SOUND WAVE IN GAS MIXTURE

Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 92, No 1, Jan 87 (manuscript received 27 Aug 86) pp 87-96

[Article by A. M. Dykhne and S. V. Pokrovskiy, Institute of Space Research, USSR Academy of Sciences]

[Abstract] Propagation of sound through a mixture of light gas and heavy gas is examined for the possibility of total reflection as a result of energy transfer from incident wave to reflected wave during their nonlinear interaction. The binary gas mixture is assumed to consist of a light component and a much heavier one in approximately equal concentrations so that it contains many light molecules and relatively few heavy ones. Thermal diffusion is then negligible and pressure diffusion becomes anomalously intense. Heat conduction and viscous friction are taken into account. The problem is analyzed first by calculation of damping within the gas volume and at the container walls in the linear approximation of gas dynamics and then according to a nonlinear theory which yields quasi-static beats, assuming that the frequencies of two interacting waves are close. Equations describing buildup of a slowly varying amplitude are derived, considering that a reflected wave can be either amplified or attenuated by nonlinear interaction with a quasi-static one. Theoretical calculations are supplemented with numerical estimates pertaining to sound waves in a long cylindrical tube with H_2 and SF_6 . References 7: 6 Russian, 1 Western (in Russian translation).

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USE OF LASERS WITH $F_A(II)$ -COLOR CENTER $KCl:Li$ CRYSTALS IN THE INTRARESONATOR LASER SPECTROSCOPY METHOD

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 13, No 8, Aug 86
(manuscript received 16 Oct 85) pp 1708-1710

[Article by V. M. Bayev, V. P. Dubov, A. N. Kireyev, E. A. Sviridenkov,
D. D. Toptygin and O. I. Yushchuk, Institute of Physics imeni P. N. Lebedev
USSR Academy of Sciences]

[Abstract] Intracavity laser spectroscopy is used for highly-sensitive detection of gases in the atmosphere and the study of the kinetics of chemical reactions and sensitivity can be increased by using lasers with strong line absorption in specific ranges. The possibility was experimentally studied of using $F_A(II)$ -color centers in $KCl:Li$ crystal for the intracavity spectroscopy method in the visible and near IR range for the study of atmospheric gases with pumping by a continuous argon laser. The mechanism is described for the formation of the $F_A(II)$ -centers in the crystal which involves the additive staining of the crystal by means of K vapor at 400-800°C and the formation of agglomerated double centers. The active element consists of polished dyed crystals 1.5 X 1 X 4 mm which is thermally treated and irradiated so that the holes are linked to the lithium atoms and the temperature is then dropped to that of liquid nitrogen. A block diagram and description is given of the experimental resonator with a cryostat containing the crystal. Pumping is by a Spectra Physics 371 argon laser. The lasing pulse repeated the pump pulse and the average length was 0.5-1 ms and the device had a sensitivity of $s \times 10^{-7} \text{ cm}^{-1}$. An intracavity absorption spectrum is given for the atmosphere (with the wavenumber range 3788-3793 cm^{-1}) showing lines for water vapor and CO_2 . Figures 2; references 9: 5 Russian, 4 Western.

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MICROWAVE CONDUCTANCE OF OXYGEN-BEARING SILICON AND INVERTED EPR-SIGNAL FROM NEW CENTERS

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 44, No 11, 10 Dec 86 (manuscript received 31 Jul 86, after revision
14 Oct 86) pp 513-515

[Article by V. M. Babich, N. P. Baran, A. A. Bugay, A. A. Konchits, and
V. M. Maksimenko, Institute of Semiconductors, UkSSR Academy of Sciences]

[Abstract] A study of silicon crystals with a high oxygen content has revealed new properties acquired as a result of long high-temperature annealing, in addition to the already known formation of thermal donors upon precipitation of SiO_x oxides. Experimental specimens were grown by the Czochralski method with $n_0 = 8 \cdot 10^{17} \text{ cm}^{-3}$ and n-type doping ($n_e = 1 \cdot 10^{15} \text{ cm}^{-3}$) or p-type doping ($n_p = 5 \cdot 10^{14} \text{ cm}^{-3}$). They were annealed at a temperature of 920 K for 2-200 h, whereupon they were tested by the method of EPR at a microwave frequency of 9.3 GHz over the 1.8-40 K temperature range, 10 mm long specimens $3 \times 3 \text{ mm}^2$ in cross-section having been placed at the antinode of the magnetic field in cylindrical microwave resonator. At liquid-helium temperatures they were found to have a high microwave conductance causing the Q-factor of the resonator to drop appreciably. This effect correlates with appearance of paramagnetic Si-2K centers in a magnetic field $H \parallel [001]$, accompanied by appearance of both donors and acceptors in the forbidden band, their spectral lines being narrow, of the order of 0.03 mT, and inverted in phase. Ultrasonic annealing at 1000 K for 3 h was found to increase their concentration, but annealing at 1150 K for only 30 min as well as interband illumination, bombardment with 1.5 MeV electrons or with γ -quanta formation of paramagnetic Si-2K centers and appearance of microwave conductance are explainable by precipitation of long oxygen chains with dislocation dipoles and preferred $\{110\}$ orientation, and movement of captured electrons. Annihilation of these Si-2K centers and of microwave conductance upon illumination is explainable by capture of holes subsequently recombining with electrons. Their annihilation upon annealing at 1150 K as well as upon bombardment with electrons or with γ -quanta is explainable by destruction of dislocation dipoles. The authors thank B. D. Shanin and V. G. Grachev for discussion and helpful comments. Figures 2; references 5: 4 Russian, 1 Western.

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OBSERVATION OF INSTABILITIES IN TIME DURING DYNAMIC SELF-DIFFRACTION OF LIGHT IN ANISOTROPIC NONHOMOGENEOUS MEDIUM

Leningrad PISMA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 13, No 2, 26 Jan 87 (manuscript received 29 Oct 86) pp 119-123

[Article by R. B. Alaverdyan, S. M. Arakelyan, A. S. Karayan, and Yu. S. Chilingaryan, Yerevan State University]

[Abstract] An experiment was performed for recording oscillations in nematic liquid crystals during propagation through them of variously polarized light with attendant self-diffraction. Homeotropically oriented 5TsB crystals, also MBBA crystals in a hybrid cell with one face homeotropic and the other plane, were reoriented by a light beam from an Ar⁺-laser ($\lambda = 0.51 \mu\text{m}$ wavelength). Measurements were made on the basis of the characteristic aberration pattern and with a weak probing light beam from a He-Ne laser ($\lambda = 0.63 \mu\text{m}$ wavelength). These measurements have yielded the dependence of the oscillation period on the intensity of linearly polarized light with an obliquely incident o-wave during threshold reorientation of the crystal and the dependence of the threshold light intensity on the ellipticity of polarization, linear polarization corresponding to zero ellipticity, in the case of a normally incident light beam. Oscillation patterns were also recorded in a 5TsB crystal in the case of two opposing normally incident coherent light beams of equal intensity (230 W/cm^2) but polarized in different directions, with their electric field vectors at right or nearly right angles. Figures 3; references 12: 8 Russian, 4 Western.

2415/5915
CSO: 1862/132

DIRECTIONAL STIMULATED RADIATION EMISSION BY HOT Ge HOLES

Leningrad PISMA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 13, No 2, 26 Jan 87 (manuscript received 27 Aug 86) pp 65-68

[Article by A. V. Muravyev, Yu. N. Nozdrin, S. A. Pavlov, and V. N. Shastin, Institute of Applied Physics, USSR Academy of Sciences, Gorkiy]

[Abstract] Directional stimulated emission of infrared radiation by hot holes in p-Ge was achieved experimentally, using an almost semiconfocal resonator with external mirrors. A specimen of p-Ge in the form of a right parallelepiped 125 mm long and $7.5 \times 4.5 \text{ mm}^2$ in cross-section with a net impurity concentration $N_a - N_d = 8 \cdot 10^{13} \text{ cm}^{-3}$, with the impurities in a ratio $N_d : N_a \approx 0.3$, was placed in the cavity of a total-internal-reflection resonator for preliminary testing. The resonator was then converted by first making the surface at one end concave-spherical with a 190 mm long radius of curvature so as to widen the field intensity range of emission in crossing electric and magnetic fields. Subsequently the lateral surfaces of the resonator were rough ground so as to cut off stimulated emission and metal mirrors were attached to both ends, a

4x4 mm² large plane one at the plane end and a 4x4.5 mm² large spherical one at the other end matching the curvature of the latter, so as to restore stimulated emission in the axial resonator modes even though with a narrower range of electric and magnetic field intensities. The intensity of radiation emission within a unit solid angle was much higher with the semiconfocal resonator than with the total-internal-reflection resonator. Figures 2; references 6: 5 Russian, 1 Western.

2415/5915
CSO: 1862/132

PHOTOINDUCED LOW-TEMPERATURE CHANGES IN OPTICAL LOSSES IN FIBER OPTICS BASED ON CHALCOGENIDE GLASSES

Leningrad PISMA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 13, No 1,
12 Jan 87 (manuscript received 17 Sep 86) pp 35-38

[Article by V. G. Borisevich, G. G. Devyatykh, Ye. M. Dianov, S. V. Ignatyev, V. G. Plotnichenko, I. V. Skripachev, M. F. Churbanov, V. A. Shipunov, and V. S. Shirayayev, Institute of Chemistry, USSR Academy of Sciences, Gorkiy]

[Abstract] An experimental study of fiber optics based on chalcogenide glasses and of changes in optical losses upon their cooling from 300 K to 77 K has revealed that the increase of optical losses is a result of photoinduced effects. Specimens of Ge₅As₃₈Se₅₇, As₃₀S₇₀, As₄₀S₆₀ fibers 400-500 μm in diameter with 10-20 μm thick teflon F-42 coating were tested in two different modes. Cooling without external illumination resulted in a narrowing and shifting of the absorption bands without an increase of optical losses above the original 0.2-2 dB/m. Lateral illumination during cooling was found to slowly decrease the transmission coefficient to a stable lower level, a level which dropped and was reached sooner with increasing illumination intensity. This effect is explained by action of photons with energy larger than the gap width producing metastable defect centers with energy levels within the gap. Illumination by a CI 10-300 U lamp with an intensity of 700 lx caused changes smaller than the measurement error at room temperature but of the order of 10⁴ times larger at 77 K. Figures 1; tables 1; references 6: 3 Russian, 3 Western.

2415/5915
CSO: 1862/129

POPULATION INVERSION IN GAPLESS SEMICONDUCTORS AS RESULT OF INTERBAND PUMPING

Leningrad PISMA V ZHURNAL TEKHNIЧЕСКОЙ ФИЗИКИ in Russian Vol 13, No 1,
12 Jan 87 (manuscript received 27 Aug 86) pp 32-35

[Article by G. M. Genkin, A. V. Okmelkov, and I. D. Tokman, Institute of
Applied Physics, USSR Academy of Sciences, Gorkiy]

[Abstract] Optical interband pumping of gapless semiconductor materials and the resulting nonequilibrium charge carrier distribution are analyzed, considering that excess photocarriers are produced by such pumping and after energy relaxation "dip" to the bottom of the respective band. Pumping sufficiently strong to produce a degenerate nonequilibrium carrier distribution can, therefore, also cause a population inversion at a band-to-band (conduction band -- valence band) transition. Emission of optical phonons at temperatures far below that corresponding to the phonon frequency is the principal mechanism of photoelectron energy relaxation, photohole energy relaxation being much slower on account of the much larger mass. Computer simulation of the pumping kinetics on the basis of the corresponding transient-state equation, including recombination as well as electron-electron scattering, has yielded the dependence of amplification and internal absorption on the frequency of interband transitions for $\text{Cd Hg}_{1-x}\text{Te}$ materials pumped by a CO_2 -laser with an intensity of 10^4 - 10^5 W/cm². The authors thank A. A. Andronov, Yu. N. Nozdrin, and V. N. Shastin for stimulating discussions. Figures 3; references 4: 1 Russian, 3 Western.

2415/5915

CSO: 1862/129

ELECTRON-PARAMAGNETIC RESONANCE IN DOPED EuO

Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY ФИЗИКИ in Russian Vol 92,
No 1, Jan 87 (manuscript received 14 Feb 86) pp 118-125

[Article by M. I. Auslender and N. A. Viglin, Institute of Metal Physics,
Ural Science Center, USSR Academy of Sciences]

[Abstract] An experimental study of electron-paramagnetic resonance in EuO single crystals and polycrystalline specimens doped with excess Eu or with up to 2 atom.% R = Gd, Sm was made at temperatures covering the 100-400 K range. Vegard's law being applicable to $\text{Eu}_{1-x}\text{R}_x\text{O}$ solid solutions, owing to their strong ionicity and strong "lanthanoidal compression", their composition could be monitored accurately by the x-ray method. The composition of EuO_{1-x} specimens could not be monitored accurately, only roughly on the basis of infrared absorption lines. Specimens with semiconductor characteristics (low electrical conductivity $\sigma = 10^{-5}$ - $5 \cdot 10^{-3}$ ohm⁻¹cm⁻¹) and specimens with metallic conductivity ($\sigma > 1$ ohm⁻¹cm⁻¹) were produced and tested, the latter in powder form

so as to avoid distortion of the EPR line symmetry by the skin effect. The electrical conductivity was measured on single crystals by the current-voltage method and the electron concentration was measured with a Hall probe. X-ray spectroscopy with ER-9 and ERS-230 instruments has yielded the temperature dependence of the EPR line width ΔH_{pp} , with a minimum at temperature $T_{min} = 170-180$ K for high conductivity specimens, whereupon the temperature coefficient of the line width was calculated. The results indicate that the minimum EPR line width decreases with increasing impurity concentration, more appreciably in the case of Gd or Sm than in the oxygen vacancies, while the temperature coefficient first increases and after semiconductor-metal transition decreases appreciably for some $\text{Eu}_{1-x}\text{R}_x\text{O}$ and remains high for others or decreases slightly for EuO_{1-x} . The effective g-factor also follows correspondingly different trends. An explanation for this is sought in electron localization, cluster formation, spin-lattice relaxation of impurity electrons, and random distortions of spectral lines not influencing the resonance field. The authors thank A. A. Samokhvalov for steady interest. Figures 1; tables 3; references 25: 11 Russian, 14 Western (2 in Russian translation).

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DISCOVERY OF NEW Ag MODIFICATION IN $\text{InSb}(110)+\text{Ag}$ SYSTEM

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 45, No 1, 10 Jan 87 (manuscript received 18 Nov 86) pp 49-51

[Article by V. Yu. Aristov, I. L. Bolotin, and V. A. Grazhulis, Institute of Solid State Physics, USSR Academy of Sciences]

[Abstract] Diffraction of slow (10-100 eV) electrons in ultrathin Ag films on $\text{InSb}(110)$ substrate surfaces at a temperature close to 10 K under a vacuum of the order of 10^{-10} torr has revealed a new Ag modification appearing during the initial stages of film buildup. The thickness of these films was varied from 0 to 20 monolayers, one monolayer corresponding to the number of $\text{InSb}(110)$ atoms per unit area: $6.74 \cdot 10^{14} \text{ cm}^{-2}$. An analysis of changes in the diffraction pattern with increasing number of monolayers indicates a transition from disordered amorphous state to order crystalline state at the $\text{InSb}(110)+\text{Ag}$ surface as the Ag film reaches a critical thickness of 4-4.5 monolayers. Evidently Ag with a b.c.c. lattice ($a = 3.4 \text{ \AA}$) rather than an f.c.c. lattice ($a = 4.1 \text{ \AA}$, $d = 2.9 \text{ \AA}$) forms on the $\text{InSb}(110)$ substrate. The fading of $\text{InSb}(110)$ reflexes under a 1-1.5 monolayer thick Ag film, moreover, cannot be attributed to "shielding" by that film but must be attributed to strong chemical interaction of Ag and InSb which breaks the translational symmetry of a few atomic layers at the substrate surface. Variance of the critical film thickness is attributable to fluctuation of the film thickness on a substrate at low temperature. The authors thank V. L. Pokrovskiy for helpful discussions. Figures 2; references: 1 Russian.

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CSO: 1862/124

IS $\text{Al}_{86}\text{Mn}_{14}$ A QUASI-CRYSTAL OR A CUBIC CRYSTAL?

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 45, No 1, 10 Jan 87 (manuscript received 30 Oct 86) pp 31-34

[Article by V. Ye. Dmitriyenko, All-Union Scientific Research Center Studying Properties of Surface and Vacuum]

[Abstract] The question as to whether compounds of the $\text{Al}_{86}\text{Mn}_{14}$ type form quasicrystalline structures with long-range orientational and translational order but noncrystallographic symmetry such as an icosahedral one is examined theoretically on the basis of experimental data on x-ray and electron diffraction, available evidence indicating that quasi-crystals must exist in nature. On the premise that these compounds form cubic crystals with an approximately 33 Å large unit cell, closeness of various hypothetical cubic reflexes to recorded icosahedral reflexes is examined as a purely geometrical problem involving comparison of corresponding calculated and measured interplanar distances. A structure with vertex vectors of the {8,13,0} class is shown to produce experimentally recorded $\text{Al}_{86}\text{Mn}_{14}$ reflexes. Cubic space groups in which six icosahedral structures can possibly belong are determined on the basis of the Landau theory which describes crystallization of an isotropic liquid with Fourier harmonics of the density ρ_G as an order parameter. According to this theory, two different cubic groups are possible for any choice of vertex vectors. They are a symmorphic group and an asymmorphic one, both with almost icosahedral symmetry but each with a different set of Fourier-harmonic phases. Most indices of recorded reflexes form naturally either a Fibonacci series u_n or a Fibonacci series multiplied by two ($2u_n$). Closeness to icosahedral symmetry being natural for Fibonacci crystals, twinning is not needed as an explanation for that closeness. The author thanks V. A. Belyakov for many suggestions, V. G. Labushkin, E. R. Sarkisov, and I. G. Tolpekin for assistance in numerical calculations. Tables 1; references 13: 2 Russian, 11 Western.

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UDC 537.84:532.582.7:532.582.81

ROTATION OF MAGNETIZED PARTICLE IN ELECTRICALLY CONDUCTING VISCOUS MEDIUM

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 4, Oct-Dec 86
(manuscript received 21 Jan 86) pp 37-42

[Article by B. M. Berkovskiy, B. E. Kashevskiy, and Yu. V. Poroshin]

[Abstract] An important problem in magnetohydrodynamics of electrically conducting media is considered, namely rotation at a constant speed of a uniformly magnetized spherical solid particle of an electrically conducting material such as iron immersed in an electrically conducting viscous medium and suspended in it by external forces. The magnetic moment of this particle is assumed to be frozen in it at any $0 \leq \theta \leq 90^\circ$ angle to the angular velocity vector, which removes the constraint of axial symmetry and thus generalizes the problem. The object is to determine the conduction currents induced in the medium around the particle, their interaction with the magnetic moment of the particle, and their effect on the Stokes moment of viscous forces acting on the particle. The medium is assumed to be an incompressible fluid and its flow is described in the Stokes approximation with negligible inertia forces, with a very low magnetic Reynolds number $N_{Re,m} \ll 1$ for both the medium and for the particle as well as a very low plain Reynolds number $N_{Re} \ll 1$ but not so low a Hartmann number $N_{Ha} < 1$. The solution to the corresponding field equations for a rotating magnetic dipole in such a configuration is sought in series of associated Legendre polynomials representing spherical harmonics. On this basis are calculated the electric potentials of the medium and the particle, the body force acting on the medium, and the additional Stokes moment acting on the particle, also the velocity profiles in the medium at various orientations of the particle. Figures 2; references 3: 2 Russian, 1 Western.

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NEW EQUILIBRIUM FORMS OF FREE SURFACE OF CONFINED MAGNETIC FLUID

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 4, Oct-Dec 86
(manuscript received 27 Feb 86) pp 11-16

[Article by V. M. Berkovskiy, V. G. Bashtovoy, and A. G. Reks]

[Abstract] An experimental study of two magnetic fluids, with a bubble of fluid resting on a horizontal plate in a uniform vertical magnetic field, has revealed new equilibrium forms of the free surface. The two fluids were MK-50 (density 1460 kg/m^3 , saturation magnetization 50 kA/m , surface tension in air 0.027 N/m) and MK-32 (density 1310 kg/m^3 , saturation magnetization 32 kA/m , surface tension in aqueous CaCl_2 solution 0.0034 N/m). In the first experiment a bubble with a volume of 450 mm^3 was poured slowly on an iron plate in a magnetic field of threshold intensity, whereupon the magnetic field intensity was raised in 80 A/m steps with a holding period of 10 min at each level. The shape of the bubble evolved and stabilized at each level of magnetic field intensity within a range between a lower critical and an upper critical, this range narrowing with increasing bubble volume. The bubble lost its topological stability and split as the magnetic field intensity was increased above the upper critical or decreased below the lower critical. In the second experiment a bubble in the form of a cylindrical column reduced to a film was held by two parallel horizontal glass or Plexiglas plates and made hydrostatically weightless by immersion in an aqueous CaCl_2 solution of the same density. Here the bubble retained its shape in a vertical magnetic field of intensity up to critical, remaining stable under mechanical loads but not so stable under asymmetric perturbations, with the critical magnetization increasing linearly with increasing column height (film thickness) but decreasing with increasing diameter. Adequate wetting of the iron plate was achieved by covering its surface with a 0.06 mm thick nonmagnetic foil. Wetting of the glass plates was prevented by adding a surfactant to the CaCl_2 solution, and the Plexiglas plates were wetted to a 42° angle. Figures 2-5: references 9: 7 Russian, 2 Western.

2415/5915

CSO: 1862/111

METHOD OF TWO-TIME GREEN FUNCTIONS IN MOLECULAR HYDRODYNAMICS OF SUPERFLUID LIQUID

Moscow TEORETICHESKAYA I MATEMATICHESKAYA FIZIKA in Russian Vol 69, No 3, Dec 86 (manuscript received 20 Nov 85) pp 439-465

[Article by Yu. A. Tserkovnikov, Institute of Mathematics imeni V. A. Steklov, USSR Academy of Sciences]

[Abstract] Correlation functions and Green functions are constructed for density and temperature fluctuations of a superfluid Bose liquid at temperatures below the critical point over the entire momentum and frequency ranges. A chain of equations relating the irreducible parts of Green functions to one another is used, with the appropriate operator basis, for derivation of equations in those Green functions, considering that the latter become related to one-particle Green functions through correlation functions for products of an odd number of operators once the gauge symmetry is broken. The resulting system of seven linear equations is solved with an extraction of singularities corresponding to fast evolution, the latter being determined by the frequency of interparticle collisions. With static susceptances as initial data, random fluctuating susceptances are calculated in terms of kinetic coefficients on the basis of the same equation chain or any other variant of perturbation theory. Comparison with results based on the equations of two-fluid hydrodynamics indicates that phenomenological macroscopic-scale parameters can be expressed through microscopic-scale quantities and thus be determined from quantum equations of motion for a system of interacting Bose particles. The author thanks D. N. Zubarev for discussing the results. References 18: 12 Russian, 6 Western (1 in Russian translation).

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UDC 532.5:534.1

FAR FIELD OF STEADY WAVES PRODUCED BY LOCAL PERTURBATION SOURCES IN STREAM OF STRATIFIED FLUID

Moscow PRIKLADNAYA MATEMATIKA I MEKANIKA in Russian Vol 50, No 6, Nov-Dec 86 (manuscript received 3 Jun 85) pp 987-995

[Article by V. F. Sannikov, Sevastopol]

[Abstract] Formation of waves during horizontal flow of a nonviscous incompressible vertically stratified fluid past point sources of perturbation is treated as a three-dimensional problem, only the steady state being considered. The differential equation for the vertical velocity component with a Brent-frequency term added and with a delta-function term on the right-hand side is formulated in the linear approximation, with appropriate boundary conditions at a source and at infinity as well as the condition of radiation. After a Fourier transformation in the space domain, this equation is solved as a Sturm-Liouville eigenvalue problem by uniform asymptotic expansions in the vicinity of mode fronts in the far field: expansions of Airy functions for a fluid body of finite depth. References 10: 7 Russian, 3 Western.

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METHOD OF CALCULATIONS FOR FLOW OF IDEAL GAS THROUGH PLANE AND AXISYMMETRIC NOZZLES WITH BROKEN-LINE CONTOUR

Moscow ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian
Vol 26, No 11, Nov 86 (manuscript received 29 Mar 85, after revision 17 Oct 85)
pp 1679-1694

[Article by A. N. Krayko, N. I. Tillyayeva, and S. A. Shcherbakov, Moscow]

[Abstract] A method of calculations for flow of an ideal gas through nozzles is outlined which combines the Godunov-Kolgan modification of the Godunov scheme with the method of characteristics, using analytical solutions at the nozzle axis (S. V. Falkovich - O. S. Ryzhov) and at an acoustic saliency (R. Vaglio-Laurin). Monotonicity of the original Godunov scheme is retained, owing to a procedure for determining "large quantities" on both sides of the grid boundary. This combination method is applicable to any arbitrary two-dimensional or three-dimensional grids. Its efficiency and precision are demonstrated on irregular grids for nozzles with broken-line contours. As a test case is selected a nozzle contour with a supersonic saliency, but resorting to the method of characteristics facilitates calculations for transonic and subsonic flow as well without restrictions on the degree of contour smoothness. Analytical solutions yield the inclination angle of the velocity vector on an acoustic line as a function of one coordinate so that the other coordinate can be found and the acoustic line can be plotted in the plane of flow. The method has been programmed on a BESM-6 high-speed computer. Figures 6; tables 1; references 29: 24 Russian, 5 Western (1 in Russian translation).

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EFFECT OF OPTICAL INHOMOGENEITIES ON SPACE COHERENCE OF RADIATION EMITTED BY LASER WITH UNSTABLE RESONATOR

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 61, No 6, Dec 86
(manuscript received 4 Mar 86) pp 1287-1294

[Article by L. A. Danilova, D. I. Staselko, and V. L. Strigun]

[Abstract] An experimental study of a laser with unstable resonator was made, for the purpose of establishing the quantitative relation between space coherence of emitted radiation and optical distorting inhomogeneities in that resonator. Theoretical relations describing the dependence of the degree of space coherence on medium-scale and large-scale inhomogeneities have been established for typical model inhomogeneities such as a medium-scale random one with a correlation radius smaller not only than the radius of the active medium but also than the dimension of the Fresnel zone and large-scale inhomogeneities such as a wedge or a lens, static or dynamic. The experiment was performed with a ruby laser in a plane-convex unstable resonator operating in the free emission mode. Ruby crystals had been grown with a high degree of perfection, 120 mm long and 16 mm in diameter. The resonator was $L = 38$ cm long and had an $M = 2.8$ magnification, formed by an opaque convex spherical mirror with an $R = 1.35$ m radius and a stack of plane-parallel glass plates. Typical inhomogeneities in a ruby crystal were subsequently simulated: static ones with glass plates produced by the Verneuil method and intentionally distorted, dynamic ones with a rotating wedge having a 4° dihedral angle and a 1.5 refractive index. Measurements with a Mach-Zander interferometer have yielded data necessary for analyzing the effect of inhomogeneities and evaluating it relative to the performance of a perfect laser crystal. The results indicate that the degree of space coherence depends on both size and shape of inhomogeneities, being influenced more by dynamic ones than by static ones. The authors thank Yu. N. Denisyuk for support, M. I. Musatov for supplying highly homogeneous ruby crystals, and V. V. Lyubimov for helpful discussions. Figures 3; references 11: 9 Russian, 2 Western (both in Russian translation).

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CSO: 1862/106

PRODUCTION-PROCESS CO₂ LASER WITH AMPLIFIED PULSE-REPETITION OPERATION

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 13, No 8, Aug 86
(manuscript received after revision) pp 1720-1722

[Article by A. M. Belenkiy, V. V. Vasil'tsov, V. S. Golubev, A. M. Zabelin, F. V. Lebedev, P. G. Leonov, D. K. Medvedev, A. A. Morozenkov, S. K. Chekin and R. G. Shakirov, Scientific Research Center for Production-Process Lasers USSR Academy of Sciences, Troitsk, Moscow Oblast]

[Abstract] High-power pulse-repetition CO₂ lasers can be used for the industrial cutting and welding of metals instead of continuous operation devices. High-frequency switching inside the laser resonator is a complex procedure and the possibility is considered of converting continuous CO₂ lasers to pulse-repetition operation by using an external oscillator while the industrial-type laser serves as an amplifier. An experimental device was set up consisting of a master ILGN-702 laser which produced radiation which could be modulated for pulse length and frequency by a chopper with an adjustable disc which is in the optical tract connecting to a TL-10S production-process laser. Square pulses at frequencies set by the chopper are obtained at the output of the amplifier. In continuous operation with amplifier power of 50 kW and master oscillator power of 270 W the output was 6.5 kW due to saturation. In pulse-repetition operation with a pulse frequency of 0-4 kHz the amplifier produced pulse peaks of 36 kW. This is due to the accumulation of population inversion between the pulses and increasing the pulse frequency reduces pulse power. Many production processes require both continuous and pulse-repetition operation and this can be attained by adjusting the radiation chopper. The master oscillator-amplifier design is preferable to pulse-repetition lasers because there is less beam divergence and it is possible to adjust pulse frequency and peak power, utilize both repetition and continuous operation and there is better beam polarization. A defect is the possibility of back reflection in the complex optical tract to the master oscillator. Figures 4; references 8: 6 Russian, 2 Western.

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C&O: 1862/10

UDC 621.373.826.038.825.2

SUPER-SHORT YTTRIUM ALUMINATE PULSE GENERATOR WITH CONTROLLED RESONATOR Q-FACTOR

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 13, No 8, Aug 86
(manuscript received 25 Nov 1985) pp 1713-1716

[Article by A. M. Valshin, V. M. Gordiyenko, S. V. Krayushkin, V. T. Platonenko and V. K. Popov, Moscow State University]

[Abstract] Solid-state lasers with passive mode-locking are now used to produce picosecond pulses for spectroscopy, study of relaxation processes and radiation, and laser and optical technology. However the energy and time

characteristics are insufficient for effective synchronization with other pulse devices. An experimental study was made of a passive mode-locked yttrium aluminate ($\text{YAlO}_3: \text{Nd}^{3+}$) laser with Q-factor resonator control. The Q-control forms a locked pulse which leads the picosecond pulse train and can be regulated within the limits of 300-1500 ns with a precision of ± 5 ns. It made it possible to reduce the lasing pulse from 35 to 15 ps, improve stability of second harmonic energy from ± 50 to $\pm 9\%$ and length stability from ± 25 to $\pm 5\%$ and raise pulse reproducibility to 99.6% thus facilitating synchronization with other laser devices. The mechanism is described for the Q-factor control and involves a feedback circuit with two photodiodes connected to a shutter and to a pulse-forming block. The experimental results were obtained by means of an Elektronika D3-28 microcomputer. Figures 3; references 6: 5 Russian, 1 Western.

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CSO: 1862/10

PERIODICALLY PULSED EXCIMER 'MASTER OSCILLATOR - REGENERATIVE AMPLIFIER' LASER SET

Leningrad PISMA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 13, No 1,
12 Jan 87 (manuscript received 9 Oct 86) pp 19-22

[Article by V. P. Ageyev, V. V. Atezhev, V. S. Bukreyev, S. K. Vartapetov,
A. I. Zhukov, V. I. Konov, and A. D. Savelyev, Institute of General Physics,
USSR Academy of Sciences, Moscow]

[Abstract] A periodically pulsed excimer laser set consisting of a master oscillator and a regenerative amplifier is proposed for improvement of the laser beam characteristics, particularly decreasing its divergence in the case of short pumping pulses and attendant high gain. Each active medium is pumped by electric discharge, both discharge circuits using magnetic switches with a common commutator so that the laser energy characteristics and the time separation between gain buildup in the two lasers can be simultaneously optimized. An experimental set was built with a Model 170 excimer laser as amplifier and a compact excimer laser having a 1 cm long amplifying medium in a 20 cm long interelectrode gap as oscillator. Tests were performed with $\text{F}_2 + \text{Kr} + \text{He}$ mixtures lasing at the $\lambda = 248$ nm wavelength, with and without injection. Emission pulses were produced at a repetition rate of 20 Hz and the beam divergence was measured through a lens with a focal length of 300 cm. The oscillator beam with a divergence of 600 μrad carried an energy of 700 μJ per pulse and was amplified to 35 mJ. The divergence of the amplified beam in the direction parallel to that of the discharge current was 140 μrad without injection and 80 μrad with injection, its divergence in the direction perpendicular to that of the discharge current was 90 μrad without and with injection. Figures 2; references 3: 2 Russian, 1 Western.

2415/5915
CSO: 1862/129

OBSERVING EFFECT OF LASER RADIATION ON LOW-FREQUENCY RAMAN SCATTERING OF LIGHT

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 45, No 1, 10 Jan 87 (manuscript received 9 Nov 86) pp 8-9

[Article by K. V. Grechushkin and A. V. Pivovarov, Scientific Research
Institute of Mechanics and Physics, Saratov State University imeni N. G.
Chernyshevskiy]

[Abstract] An experimental study was made for the purpose of observing the effect of laser radiation on low-frequency Raman scattering of light. Specimens of water bidistillate and aqueous glucose solution as well as specimens of polycrystalline aminoacids (valine, leucine, isoleucine, threonine, histidine, phenylalanine) were irradiated by a He-Cd laser ($\lambda = 4416 \text{ \AA}$ wavelength) with a power of 30 mW. Spectrograms covering the $30\text{--}300 \text{ cm}^{-1}$ range were recorded in less than 120 s with the aid of a DFS-12 diffractive double monochromator. Laser radiation was found to have changed the low-frequency scattering spectrum of all these substances so as to indicate a restructurization of the hydrogen bonds. Slowness of this process in both forward and reverse directions is evidently caused by structural relaxation. Figures 3; references: 6 Western.

2415/5915
CSO: 1862/124

RELAXATION OF MUON POLARIZATION IN MUONIUM WITH QUADRUPOLE INTERACTION

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 50,
No 12, Dec 86 pp 2340-2344

[Article by V. G. Baryshevskiy, S. A. Kuten, and V. I. Rapoport, Belorussian State University]

[Abstract] The effect of quadrupole interaction in a muonium nondiffusing in a crystal on the relaxation of the muon spin in a nonuniform electric field is analyzed and evaluated on the basis of the applicable theory, a theory in which muonium is described by a Hamiltonian containing a $\omega_0 S \cdot I$ term (ω_0 - frequency of hyperfine interaction, S - electron spin, I - muon spin) and a $\frac{1}{6} Q_{ik} \phi_{ik}$ term (Q_{ik} - operator of quadrupole muonium moment, ϕ_{ik} - generalized tensor of electric field gradient). The system of 15 coupled first-order linear differential equations describing the kinetics of muonium polarization characteristics, six ones for their longitudinal components, is reduced by transformation of coordinates and a Laplace transformation to a characteristic algebraic equation the roots of which in the nontrivial case of nonzero relaxation can be found by numerical methods only. It is solved accordingly for a muonium in an α -SiO₂ crystal at temperatures below 120 K with a 4560 MHz frequency of hyperfine interaction and at room temperature with a 4510 MHz frequency of superfine interaction, without a magnetic field or in weak to medium-strong magnetic fields corresponding to conditions under which measurements have been made. Calculations are made only for low and intermediate frequencies of electron spin reversal, assuming isotropic relaxation, inasmuch as no precession at muonium frequencies will occur at high relaxation frequencies. References 13: 6 Russian, 7 Western.

2415/5915
CSO: 1862/104

FORMATION OF INDUCTION AND ECHO SIGNALS IN ANGULAR DISTRIBUTION OF γ -RADIATION FROM ORIENTED NUCLEI

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 50, No 12, Dec 86 pp 2296-2303

[Article by L. N. Shakhmuratova, Kazan State Pedagogical Institute]

[Abstract] The formalism of pulsed nuclear-magnetic resonance is used for analyzing experimentally observed formation of induction and echo signals in the angular distribution of γ -radiation from an array of oriented nuclei. The anisotropy of this distribution is described by statistical tensors related to the density matrix through Clebsch-Gordon coefficients. Considering that oscillating induction and echo pulses are the response of a nuclear spin system to excitation by pulses much longer than the characteristic time of reversible transverse relaxation, the possibility of stimulating an echo by two long pulses separated by some time interval or by a single pulse of intricate form is examined theoretically for an axial geometry of the experiment. The echo signal is presumably recorded at the end of the single excitation pulse or at the end of the second of two successive excitation pulses, that second pulse also playing an auxiliary role. A cumulative echo stimulated by multipulse excitation with small-area pulses and representing a memory effect is theoretically shown to be the response of a system with an arbitrary spin under such an excitation. Figures 2; references 21: 5 Russian, 16 Western.

2415/5915

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C-EVEN CHARMONIUM AS TOOL FOR STUDYING POLARIZATION OF GLUONS

Moscow YADERNAYA FIZIKA in Russian Vol 44, No 6(12), Dec 86
(manuscript received 7 Apr 86) pp 1551-1553

[Article by A. V. Batunin and S. R. Slabospitskiy, Institute of High-Energy Physics, Serpukhov]

[Abstract] Decay of C-even charmonium states is considered, a charm meson being produced principally by interaction of gluons from original hadrons. Measuring the angular distributions of decay products is shown to be, therefore, an effective tool for studying the polarization of gluons. In the hadron zoo there are very few charm quarks, not more than 1%, so that a charm meson can be produced only by two-gluon or quark-antiquark annihilation with subsequent $X_c \rightarrow \gamma J/\psi (\rightarrow l^+ l^-)$ decay. An analysis of interaction vertices and then angular photon and lepton distributions resulting from decay of a gypsy meson confirms that polarization effects occur only in the case of particle beam or target polarization. Annihilation of quarks with nonzero longitudinal and transverse polarizations as well as two-gluon decay into a 2^{++} -meson

appreciably influence the angular photon and lepton distributions, while linear polarization of partons generally adds a trivial multiplier to the angular distributions. These conclusions extend unambiguously to products of $\gamma\gamma$ -interaction. Figures 1; tables 2; references 5: 2 Russian, 3 Western.

2415/5915

CSO: 1862/100

TRANSITION FROM CURRENT QUARKS TO CONSTITUENT QUARKS AND PROPERTIES OF TOPONIUM

Moscow YADERNAYA FIZIKA in Russian Vol 44, No 6(12), Dec 86
(manuscript received 29 Dec 85) pp 1542-1550

[Article by A. A. Bykov and I. M. Dremin, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences]

[Abstract] A model of the interaction potential in the Schrödinger equation is proposed for quarks, considering a "step" change of quark mass upon transition from current quarks to constituent ones at some critical distance between them. Bottomium and toponium properties are analyzed and evaluated by numerical solution of the Schrödinger equation with this potential. For a bottomium are calculated the widths of radiative $E1$ -transitions and hadron decays. For a toponium are calculated its mass, lepton width and hadron width in $1S$ - $5S$ and $1P$ - $5P$ states, and widths of radiative $E1$ -transitions. On the basis of these data and the potential with a "step" is proposed a hypothesis about quarks having a dynamic mass related to the scalar part of the quark-antiquark potential, this hypothesis being verifiable by two-gluon decay of a toponium or by its radiative decay into a γ -quantum and a Higgs particle. The authors thank I. V. Andreyev for many helpful discussions and Ye. L. Feynberg for critical comments. Figures 3; tables 3; references 13: 4 Russian, 9 Western.

2415/5915

CSO: 1862/100

CONTRIBUTION OF WEAK NEUTRAL Z^0 -CURRENT TO AMPLITUDE OF ELASTIC LEPTON SCATTERING IN MAGNETIC FIELD

Moscow YADERNAYA FIZIKA in Russian Vol 44, No 6(12), Dec 86
(manuscript received 24 Dec 85) pp 1527-1532

[Article by V. Yu. Linkov, I. A. Obukhov, V. K. Peres-Fernandes, and V. R. Khalilov, Moscow State University]

[Abstract] The contribution of a weak neutral Z^0 -current to the amplitude of elastic lepton scattering in a magnetic field is calculated on the basis of the Weinberg-Salam model, the contribution of a weak charged W -current having already been calculated in an ongoing study of radiative corrections to the

mass and the magnetic moment of a lepton. The neutral Z^0 -current is, in the second-order perturbation theory, described properly by the energy diagram. The magnetic field is stipulated as a four-potential field $A_\mu = (0, 0, Hx, 0)$ and physical units are defined so that $\hbar = c = 1$. Calculations using the appropriate mass operator and Green function yield both real and imaginary parts of the sought contribution, the imaginary part being related to the probability of Z^0 -boson emission by a lepton and namely equal to half that probability. The double integral in the expression for that contribution can be evaluated approximately for the extreme cases of a lepton in very strong and very weak magnetic fields. In a very strong magnetic field or with an ultrarelativistic lepton energy the contribution of a weak neutral Z^0 -current is found to be comparable with that of a weak charged W-current. Figures 2; references 13: 8 Russian, 5 Western.

2415/5915

CSO: 1862/100

PECULIARITIES OF INCLUSIVE PROTON SPECTRA AND THEIR RELATION TO INTERACTION DYNAMICS OF HIGH-ENERGY HEAVY IONS

Moscow YADERNAYA FIZIKA in Russian Vol 44, No 6(12), Dec 86
(manuscript received 20 Nov 85) pp 1476-1488

[Article by V. N. Russkikh, Moscow Institute of Engineering Physics]

[Abstract] Experimentally observed peculiarities of inclusive proton spectra are analyzed theoretically on the basis of the appropriate hydrodynamical model. This model contains a system of equations describing the dynamics of nuclear-nuclear collisions for a three-dimensional collision geometry with initially spherical nuclei, an equation of state which determines the properties of the medium as functions of the ion concentration and the temperature. The system is assumed to be "frozen" with respect to Lagrangian elements used for solution of the model equations by numerical methods, not instantaneously and without free dispersal. From momentum and velocity distributions are determined the inclusive invariant cross-sections for proton yield, theoretical results based on the hydrodynamical model agreeing closely with experimental data on collisions of 0.4-10 GeV nucleons. According to this hydrodynamical model, the described system features a strong spatial nonhomogeneity corresponding to nonuniformity of its macroscopic properties, and the spectator mechanism plays a major role in triggering interaction between heavy ions. The model yields a velocity shift between a thermal source and the target, and an only approximately universal temperature of a thermal source. For collisions of like high-energy nuclei, with energy above 2 GeV each, the model yields different proton velocity spectra of central and peripheral collisions, also proton momentum spectra with large slopes. The inclusive spectra are found not to be very sensitive to changes in parameters of the model so that more precise characteristics of the interaction process such as exclusive distributions of secondary particles or correlational characteristics of the reaction

products yield are required for analysis based on the nuclear equation of state. The authors thank Yu. B. Ivanov, V. I. Manko, I. N. Mishustin, and L. M. Satarov for many helpful discussions. Figures 8; tables 2; references 22: 4 Russian, 18 Western.

2415/5915
CSO: 1862/100

NEW FORM OF RADIOACTIVITY

Moscow YADERNAYA FIZIKA in Russian Vol 44, No 6(12), Dec 86
(manuscript received 16 Dec 85) pp 1421-1431

[Article by G. A. Pik-Pichak, Institute of Atomic Energy imeni I. V. Kurchatov]

[Abstract] The new form of radioactivity which involves emission of a lighter nucleus from a decaying heavier one such as ^{14}C from $^{222,223,224}\text{Ra}$ or $^{24,25}\text{Ne}$ from ^{235}U and ^{231}Pa is analyzed quantitatively, discovery of this phenomenon dating back to 1984. The probability of such a decay is calculated, assuming that the law of energy conservation applies here. Both parent and daughter nuclei are assumed to be generally spherical in shape, elliptical deformation in the process being then included appropriately for particular nuclei. The decay process is described as a fission reaction rather than as an α -decay, the subbarrier path along the Lagrangian R_L -coordinate (center-to-center distance between parent and daughter nuclei) from the center of the parent nucleus to the point at which the daughter nucleus breaks away being much shorter in the former case. The mass factor, a function of the R_L -coordinate, is first estimated from the kinetic energy in the hydrodynamic model of a homogeneous incompressible ideal fluid and then calculated in the quantum approximation applicable to a nucleus as a quantum system. The potential energy as a function of the R_L -coordinate, different before and after breakaway of the daughter nucleus owing to a change of the subbarrier path, is calculated from the Schrödinger equation for degrees of freedom in the R_L -coordinate. The penetration of the Coulomb barrier is determined from that equation with the appropriate boundary condition at $R_L \rightarrow \infty$ and from the lifetime of the daughter nucleus in the quasi-classical approximation. Some results of calculations are found to agree closely with experimental data. Figures 9; tables 3; references 21: 7 Russian, 14 Western.

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EXPERIMENTAL DETERMINATION OF DURATION OF FISSION REACTION INVOLVING NUCLEI
 $^{22}\text{Ne} + ^{238}\text{U}$

Moscow YADERNAYA FIZIKA in Russian Vol 44, No 6(12), Dec 86
(manuscript received 24 Dec 85) pp 1389-1395

[Article by V. N. Bugrov, V. G. Vinogradov, and S. A. Karamyan, Joint Institute of Nuclear Research]

[Abstract] An experiment was performed for the purpose of determining the duration of the nuclear fission reaction in the $^{22}\text{Ne} + ^{238}\text{U}$ system. A beam of ^{22}Ne ions was extracted from the U-300 accelerator at the Nuclear Reactions Laboratory of the Joint Institute for bombardment of a UO_2 single crystal, after passage through a collimator with the last diaphragm 1 mm in diameter and then through a set of moderating foils. The (100) face of the UO_2 target had been mechanically and chemically treated. The crystal was initially oriented with its $\langle 100 \rangle$ axis at a 150° angle, its $\langle 110 \rangle$ axis at a 105° angle, and its $\langle \bar{1}\bar{1}0 \rangle$ axis at a -165° angle to the impinging ion beam. Measurements were made with three track detectors, glass devices, each facing the target along a different one of these three crystallographic axes and recording the shadow minima in the space distribution of fission fragments, also as the target was rotated. The dependence of these minima on the duration and the products of the fission reaction as well as the dependence of their angular width on the ion dose along each crystallographic axis of the UO_2 target have been established as a result. An analysis of the data on the basis of inelastic interaction mechanics, taking into account anisotropy, has yielded the long-life fission component in the $^{22}\text{Ne} + ^{238}\text{U}$ system with a life of approximately $2 \cdot 10^{-17}$ s and extractable by bombardment with 172 MeV ^{22}Ne ions at a rate not higher than 10^{-10} s^{-1} . The authors thank G. N. Flerov and Yu. Ts. Oganessian for interest, and A. F. Tulinov for supplying UO_2 single crystals. Figures 4; references 26: 14 Russian, 12 Western.

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ELASTIC SCATTERING ^3He IONS BY CARBON ISOTOPES

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 50, No 9, Sep 86 pp 1840-1846

[Article by N. S. Zelenskaya and A. K. Morzabayev]

[Abstract] Elastic scattering of 16-22 MeV ^3He ions by ^{12}C , ^{13}C , ^{14}C nuclei is analyzed quantitatively, with consideration of attendant exchange processes. The corresponding cross-sections and the angular distribution of scattered particles are determined on the basis of the optical model, the parameters of optical potentials and their values having been selected so that the real part of the center potential makes the depth of this potential approximately equal to the depth of the single-nucleon potential multiplied by the number of nucleons in an incident particle and that the imaginary parts of both center and spin-orbital potentials do not contribute to exchange processes. Calculations by the method of distorted waves with finite interaction radius yield the amplitude of exchange processes during scattering, whereupon the energy

dependence and the isotope dependence of the sought cross-sections and angular distribution are more precisely determined. The cross-section for exchange processes is found to depend much more than the cross-section for potential scattering on the mass number of the target nucleus so that, when the energy spectrum of incident particles is narrow, the angular distribution of scattered particles can be described by a single set of optical potentials for successive isotopes. Figures 6; tables 3; references 15: 7 Russian, 8 Western (1 in Russian translation).

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UDC 539.17

DECAY OF ^{158}Tb AND POSSIBILITY OF MORE PRECISELY DETERMINING MASS OF ELECTRON NEUTRINO

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 50, No 9, Sep 86 pp 1776-1785

[Article by V. M. Gorozhankin, V. B. Brudanin, Ts. Vylov, K. Ya. Gromov, A. F. Novgorodov, and V. N. Prokovskiy, Nuclear Problems Laboratory, Joint Institute of Nuclear Research, N. I. Rukhadze, Tbilisi State University, and Ch. Branson, Center of Nuclear Spectroscopy and Mass-Spectrometry, Orsay (FRANCE)]

[Abstract] Following the earlier alleged discovery by R. S. Raghavan of an ultralow-energy K-capture branch to the 1187.1 keV ^{158}Gd level in decay of ^{158}Tb and subsequent analysis by D. G. Burke indicating that existence of such a branch would violate the energy balance, another study of ^{158}Tb decay was made for verification and refinement of the reaction scheme. Both ^{158}Tb and $^{157}\text{Tb} + ^{158}\text{Tb}$ mixture were produced in the $^{158}\text{Dy}(n)^{157}\text{Dy}(8.1\text{ h},)^{157}\text{Tb}(n)^{158}\text{Tb}$ reaction. The γ -spectra of these sources (^{158}Tb with only 1% impurity) in the low-energy region as well as $\gamma\gamma$ -coincidences and $X\gamma$ -coincidences were measured with Ge(Li)-detectors and a 3-dimensional amplitude-time spectrometer. A scheme of ^{158}Tb decay was constructed on the basis of available data covering all experiments and the energy ^{158}Tb decays was calculated on the basis of the relative probability of electron K-capture, which depends on that energy. The results indicate that none of the experiments performed so far confirms the existence of a K-capture branch to the 1187.1 keV ^{158}Gd level, but they indicate the possibility of electron capture to 1263.4 keV and 1265.3 keV ^{158}Gd levels if the energy of ^{158}Tb decay is sufficiently high. An ultralow K-capture branch does therefore not exist in ^{158}Tb decay, and it does not appear feasible to more precisely determine the mass of the electron neutrino on the basis of ^{158}Tb decay. Figures 4; tables 4; references 26: 6 Russian, 20 Western.

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DOES THE TETRANEUTRON EXIST?

Moscow YADERNAYA FIZIKA in Russian Vol 44, No 3(9), Sep 86
(manuscript received 10 Jan 86) pp 842-844

[Article by R. Ya. Kezerashvili, Institute of Physics, USSR Academy of Sciences]

[Abstract] The reaction of a negative pion and ^4He producing a positive pion and a four-neutron system is considered. It was shown that in the range supposed for the reaction the interaction in the final state of the $4n$ system would be strong and would make it impossible to detect the tetraneutron. Hyperspherical functions were applied to wave equations for the initial state and the four interacting neutrons and made it possible to determine the differential cross-section of the process. Computations for the cross-section are given. Neutron resonance is also considered for a ^3He reaction. Experimental and theoretical data from the literature also indicate that a linked state of four neutrons is impossible. Figures 2; references 17: 7 Russian, 10 Western.

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THEORETICAL BASIS FOR SEARCH FOR HIGGS BOSON IN γ -MESON DECAY

Moscow YADERNAYA FIZIKA in Russian Vol 44, No 3(9), Sep 86 pp 803-809

[Article by M. I. Vysotskiy and A. S. Losev, Institute of Theoretical and Experimental Physics, State Committee for Utilization of Atomic Energy]

[Abstract] Several variants of $N = 1$ Supergravitation ($N = 1$ SUGRA) theories in which symmetry is broken because of the superhiggs effect predict the existence of a light Higgs boson. The standard minimum model for electroweak interaction leads to a lower limit for Higgs boson mass of 7.6 GeV so that there would be a low probability of observing the Higgs boson. The detection of a light Higgs boson would indirectly confirm the $N = 1$ SUGRA theories. The conditions are described for the appearance of a light Higgs boson and its interaction with quarks in the $N = 1$ SUGRA theories. Computations are given for the probability of the decay of γ -mesons into Higgs bosons with hadrons and into Higgs bosons with photons. It is shown that the light Higgs boson should be sought in the decay process leading to Higgs bosons and photons which becomes more likely relative to the decay to Higgs bosons and hadrons as the mass of the Higgs bosons increases. Figures 5; references 12: 4 Russian, 8 Western.

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NEUTRINO ELECTROMAGNETIC CHARACTERISTICS AND POSSIBLE SEMIANNUAL VARIATION
CYCLE IN NEUTRINO FLUX FROM SUN

Moscow YADERNAYA FIZIKA in Russian Vol 44, No 3(9), Sep 86 pp 677-680

[Article by M. B. Voloshin, M. I. Vysotskiy and L. B. Okun, Institute of
Theoretical Physics, State Committee for Utilization of Atomic Energy]

[Abstract] If the neutrino magnetic moment μ_ν (and/or electric dipole moment) is of the order of $\mu = 10^{-10}$ Bohr magneton units then when passing through the solar magnetic field perpendicular to the trajectory the neutrino should change from left-hand to right-hand helicity under active sun magnetic conditions. This effect should lead to a reduction of the observed neutrino flux since right-hand neutrons are not detectable. An eleven-year cycle for solar boron neutrino flux has been observed but there should also be a six-month cycle due to processes which weaken the toroidal magnetic field near the solar equator and the latter's inclination which affects the neutrino flux observable from the earth. When the earth is closest to the sun's equatorial plane the flux is greatest and when it is furthest away the flux is least. The cycle is partly confirmed by data from 1979-1982 which was the last active solar period. A large-scale liquid argon solar neutrino scattering detector now under consideration could verify the supposed variation cycle during the next active solar period (1989-1991) or lead to a correction of suppositions as to the neutrino magnetic moment and the solar magnetic field. References 14: 3 Russian, 11 Western.

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SEARCH FOR DECAYS OF CHARMED PARTICLES IN NEUTRINO EXPERIMENT WITH NUCLEAR
PHOTOEMULSIONS LOCATED IN FERMILAB 15-FOOT BUBBLE CHAMBER

Moscow YADERNAYA FIZIKA in Russian Vol 44, No 3(9), Sep 86 pp 649-660

[Article by R. Ammar, Kansas University, U.S., V. V. Ammosov, Institute of High-Energy Physics, Serpukhov, A. Bakich, Sidney University, Australia, V. I. Baranov, Institute of High-Energy Physics, Serpukhov, T. Burnett, Washington University, U.S., Yu. A. Batusov, Joint Institute of Nuclear Research, Dubna, S. A. Bunyatov, Joint Institute of Nuclear Research, Dubna, A. O. Vaysenberg, Institute of Theoretical and Experimental Physics, Moscow, R. Wilkes, Washington University, U.S., B. Wilczynska, Institute of Nuclear Physics, Cracow, Poland, H. Wilczynski, Institute of Nuclear Physics, Cracow, Poland, L. Voyvodik, Fermi National Accelerator Laboratory, U.S., W. Wolter, Institute of Nuclear Physics, Cracow, Poland, B. Wosiek, Institute of Nuclear Physics, Cracow, Poland, V. A. Gapiyenko, Institute of High-Energy Physics, Serpukhov, P. A. Gorichev, Institute of Theoretical and Experimental Physics, Moscow, J. Gress, Kansas University, U.S., R. Davis, Kansas University, U.S., O. K. Yegorov, Institute of Theoretical and Experimental Physics, Moscow, M. Ivanova, Plovdiv University, Bulgaria, N. Kwak, Kansas University, U.S., V. I. Klyukhin, Institute of High-Energy Physics, Serpukhov, E. D. Kolganova, Institute of

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[Abstract] The experiment is described in which BR-2 nuclear photoemulsion is placed directly inside the working area of the Fermilab 15-ft bubble chamber so as to obtain maximum exposure to secondary interaction and decay products while the magnetic field in the chamber makes it possible to determine particle charges and momenta. 200 layers of 400-500 micrometer layers were used for each session under cryogenic temperatures (approx. 30°K). The emulsion was exposed to a broad energy range muon neutrino beam and in the first session (with deuterium in the chamber) 90 events were observed. In the second session the chamber was filled with a neon-hydrogen mixture and there were approximately 400 neutrino interactions. An analysis is given of the experiments. In five of the events decays were observed of short-lived particles and of these four were interpreted as neutrino charged current interactions with decays of charmed Λ_c^+ baryons and D^+ , D^0 , D^0 mesons. The Λ_c^+ decay was of a type not previously observed ($\Lambda_c^+ \rightarrow \pi^+ \pi^+ K_m^-$). The charmed particle decay events amounted to 4% of the number of neutrino charged current interactions. Figures 2; references 14: 6 Russian, 8 Western.

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RELATIVISTIC EFFECTS IN PRODUCTION OF HIGGS BOSON IN RADIATIVE DECAY OF QUARKONIUM

Moscow YADERNAYA FIZIKA in Russian Vol 45, No 1, Jan 87
(manuscript received 22 Apr 86) pp 152-157

[Article by I. G. Aznauryan, S. G. Grigoryan, and S. G. Matinyan, Yerevan Institute of Physics]

[Abstract] Relativistic effects in production of a neutral scalar Higgs boson in decay of a heavy vector quarkonium according to the radiative Wilczek mechanism and in its subsequent interaction with quarks are considered, only one H^0 -boson existing in the Glashow-Weinberg-Salam model. The matrix element corresponding to the $V \rightarrow H^0 \gamma$ process is evaluated according to the noncovariant perturbation theory for the $V \rightarrow H^0 + \gamma$ decay, after the vertices of the $V \rightarrow q\bar{q}$ transition in the infinite-momentum system have been determined. The multiplier is $\sqrt{3}$, the $H^0 q$ -interaction constant is $(\sqrt{2}G)^{1/2}_m$ and thus increases linearly with increasing quark mass. Analogous relations are obtained for a neutral pseudoscalar Higgs boson P^0 . The nonrelativistic ratio of $V \rightarrow H^0 + \gamma$ decay width to $V \rightarrow \mu^+\mu^-$ decay width is corrected on this basis with a relativistic factor of p^2/m^2 order, the effect being that this ratio decreases. The authors thank N. L. Ter-Isakyan for helpful discussions. Figures 3; references 27: 6 Russian, 21 Western.

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HARTREE-FOCK DESCRIPTION OF DEFORMED THULIUM ISOTOPES

Moscow YADERNAYA FIZIKA in Russian Vol 45, No 1, Jan 87
(manuscript received 16 Dec 85) pp 45-52

[Article by A. Ye. Barzakh and V. Ye. Starodubskiy, Leningrad Institute of Nuclear Physics, USSR Academy of Sciences]

[Abstract] Latest data on odd-even and odd-odd thulium isotopes $^{157-169}\text{Tm}$ are evaluated, data pertaining to their radii, masses, and electromagnetic moments measured in the laser-nuclear facility with an IRIS mass-separator at the Leningrad Institute of Nuclear Physics. Calculations for an interpretation of these data are based on the Hartree-Fock method, using either S3 or SkM' interaction force with axisymmetrically deformed nuclei. The calculated quadrupole moments agree closely with the measured ones. With regard to the mean-square charge radii, calculations based on the SkM' interaction force reveal their dependence on the isotope better than calculations based on the S3 interaction force and agreement with experimental data ceases abruptly for "soft" nuclei with $N \leq 94$ neutrons, evidently because the Hartree-Fock theory does not

account for the increasing role of zero-point vibrations. Changes in the mean-square charge radii according to the spherical Hartree-Fock model differ from those according to the Myers-Swiatecki and are evidently more reliable. Calculated magnetic moments, decoupling parameters, and absolute magnitude of total binding energy of Tm nuclei with spins $I = 1/2$ and $I \neq 1/2$ also agree closely with experimental data. The authors thank G. D. Alkhazov, B. L. Birbrair, and V. P. Denisov for interest and valuable discussions. Figures 4; tables 4; references 22: 6 Russian, 16 Western.

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RELATIVISTIC CORRECTION TO THREE-NUCLEON BINDING ENERGY

Moscow YADERNAYA FIZIKA in Russian Vol 45, No 1, Jan 87
(manuscript received 7 Jan 86) pp 26-32

[Article by F. M. Lev, Northeastern Combined Scientific Research Institute, Far Eastern Science Center, USSR Academy of Sciences]

[Abstract] A three-nucleon system is considered in the $1/c^2$ approximation according to quantum theory, assuming that the conditions of relativistic invariance and separability as well as correspondence with field theory are satisfied. First the operator of two-nucleon interaction energy is determined in this approximation, after such a system of two nucleons with $1/2$ -spin each has been described with the aid of the corresponding wave function, and then in the nonrelativistic approximation with Poincaré operators. In the case of electromagnetically interacting nucleons one can use the diagrams of one-photon exchange and the interaction energy operator can be nonrelativistically normalized. The three-nucleon binding energy is then calculated by first calculating the two-nucleon interaction potential with the aid of the Schrödinger equation which fits experimental data, then extending the result to three-nucleon interaction and refining it for the relativistic case with the aid of Sokolov operators. References 25: 11 Russian, 14 Western.

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QUADRUPOLE COLLECTIVE MOTION: OLD AND NEW APPROACHES TO DESCRIPTION OF EXPERIMENT

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 51, No 1, Jan 87 pp 66-71

[Article by O. K. Vorov and V. G. Zelevinskiy]

[Abstract] Quadrupole low collective excitations in spherical nuclei have been treated in terms of appropriately interacting bosons, in the approximation of random phases including harmonic phonons. This interaction, which appears

in the phenomenological Hamiltonian, is now treated in two ways: "old phenomenology" based on adiabaticity of collective motion in a soft nucleus with anharmonic corrections to the potential energy and "new phenomenology" based on the model of interacting bosons which includes only pairwise boson-boson interactions but also includes a monopole s-boson. The adequacy of both approaches to description of experimental data is demonstrated on a large group of nuclei with zero equilibrium deformation, specifically $^{194,196,198}\text{Pt}$ and ^{104}Ru , namely on energy levels of allowed E2-transitions, some amplified and some inhibited. Calculations according to the "new phenomenology" have been made using two versions of the Interacting Bosons Model, IBM-2 and IBM+g. A comparison indicates that the "old" model of adiabatic collective motion describes low quadrupole excitations over a wide range of even-even nondeformed nuclei at least as accurately as the "new" model, while the latter conforms with conventional concepts about the structure of a nucleus in terms of mean field, quasi-particle pairing, and particle-hole interaction. Figures 8; references 20: 8 Russian, 12 Western (1 in Russian translation).

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SINGULARITIES IN QUADRATIC FEYNMAN DIAGRAMS FOR VARIOUS MECHANISMS OF NUCLEAR REACTIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 51, No 1, Jan 87 pp 189-194

[Article by L. D. Blokhintsev, Kh. D. Razikov, M. K. Ubaydullayeva, and R. Yamukhamedov]

[Abstract] Nonrelativistic Feynman diagrams for mechanisms of nuclear reactions are examined, including not only real but also complex singularities for unstable as well as stable vertices in a one-loop and specifically quadratic diagram. Analytical properties of any quadratic diagram with external particles and mass surface are established in Galilean-invariant variables η_{ij} , considering all three topologically nonequivalent variants of such a diagram with respectively different directions of inner lines. For illustration, appropriate quadratic diagrams are constructed for the amplitude of $^6\text{Li}(o\ o)^6\text{Li}$ scattering ($A = B = ^6\text{Li}$, $x = y = ^4\text{He}$, $i = 3 = p$, $2 = ^5\text{He}$, $4 = ^5\text{Li}$) and the amplitude of $^8\text{B}(dd)^8\text{B}$ scattering ($A = B = ^8\text{B}$, $x = y = ^2\text{H}$, $1 = 3 = ^3\text{He}$, $2 = ^5\text{Li}$, $4 = p$). Locations of intrinsic singularities of the scattering amplitude are determined in the system of η_{24} , η_{13} , z coordinates. Figures 3; tables 1; references 6: 5 Russian, 1 Western.

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STATES OF ^{149}Eu EXCITED DURING DECAY ^{149}Gd

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 51, No 1, Jan 87 pp 2-7

[Article by I. Adam, Zh. T. Zhelev, D. Zakoucki, B. Kracik, M. M. Mikhaylova, and I. Penev, Institute of Nuclear Physics, Czechoslovakia; Institute of Nuclear Research and Nuclear Power Engineering, Bulgaria]

[Abstract] An experimental study of ^{149}Gd decay was made for a determination of resulting ^{149}Eu states. Specimens of ^{149}Gd had been produced by spallation of an Er-target with 660 MeV protons, Gd then being extracted radiochemically and segregated in a mass-separator for subsequent measurement of γ -spectra with a Ge(Li)-Na(Tl) anti-Compton spectrometer. Measurements were continued for 350 days with a total exposure time of 600 h after bombardment of the target. Data obtained in this study include γ -spectra of ^{149}Gd , integral coincidences of γ -rays during ^{149}Gd decay, and schemes of ^{149}Eu levels during ^{149}Gd decay. The energy of excited ^{149}Eu states was calculated from experimental data on the basis of a semiphenomenological model describing interaction of an odd nucleon and anharmonic vibrations of an even-even core, including octupole vibrations, substantially more adequate than the model of boson-fermion interaction. Figures 1; tables 4; references 23: 10 Russian, 13 Western.

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CSO: 1862/133

SOLITONS IN COUPLED ELECTRONIC-NUCLEAR MAGNETIC SYSTEM OF ANTIFERROMAGNETIC CsMnF_3

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 45, No 1, 10 Jan 87 (manuscript received 27 Nov 86 pp 55-57)

[Article by S. A. Govorkov and V. A. Tulin, Institute of Problems in Micro-electronic and Extra-Pure Materials Technology, USSR Academy of Sciences]

[Abstract] An experimental study of hexagonal antiferromagnetic CsMnF_3 was made, strong dynamic coupling between its nuclear magnetic and electronic magnetically ordered subsystems known to give rise to low-frequency elementary excitations. Nonlinear effects have been detected in that region of the spectrum, evidently related to nonlinearity of the effective magnetic field which the nuclear magnetic subsystem produces by the mechanism of hyperfine interaction on antiferromagnetic sublattices. A high-frequency external field was found to saturate the nuclear-magnetic resonance at a frequency ω within a narrow line between the two frequencies corresponding to the two stable states in which the system can exist under these conditions within some range

of saturating power. The saturating process in CsMnF_3 can be a continuous one as the pumping power changes from $\langle m \rangle_T$ to $\langle m \rangle_\omega$ and back ($\langle m \rangle_T$ - mean equilibrium magnetization at temperature T) or a jump process with hysteresis, depending on the orientation of the external magnetic field in the basis plane of the CsMnF_3 crystal. A specimen of CsMnF_3 in the form of a parallelepiped with a 3:2:1 ratio of sides was placed in a helical resonator in a magnetic field of 3.2 kOe intensity at a temperature of 1.24 K. A pumping magnetic field alternating at a frequency of 1126 MHz produced emission with a peak at a frequency close to half the pump frequency. The entire low-frequency range of the emission spectrum was recorded as the pumping power was gradually reduced to the critical minimum level $\langle m \rangle_T$. The frequency of that narrow line between the two stable states was found to depend on the pumping power, their natural frequencies being determined either by the magnitude of the nuclear magnetization between $\langle m \rangle_\omega$ and $\langle m \rangle_T$ or, because of space dispersion, by the also power-dependent dimensions of two crystal regions (or only one) radiating a magnetic field at a frequency within a solitary narrow line between the frequency of nuclear-magnetic resonance and half the pump frequency. Figures 2; references 5: 3 Russian, 2 Western.

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UDC 535.411:535.345.6

THEORY OF INTERFERENCE-TYPE BAND REFLECTORS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 61, No 6, Dec 86
(manuscript received 1 Apr 86) pp 1346-1350

[Article by Yu. N. Markov]

[Abstract] For design optimization of triple-layer interference coatings used as band reflectors, analytical expressions are derived which relate the three respective refractive indexes. This is done by the method which has already been applied to synthesis of band-pass filters. On this basis, and with the refractive index of the substrate material given, are then determined the refractive indexes of the three layers necessary for ensuring a given bandwidth with respect to a given minimum reflection coefficient. These refractive indexes must and can be matched by appropriate materials. The spectral characteristics of the coating are then calculated for control, which can be done with the aid of a computer. Figures 3; references 8: 5 Russian, 3 Western.

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UDC 535.317.1

SYNTHESIS OF IMAGES OF OBJECTS VIEWED THROUGH RANDOMLY NONHOMOGENEOUS MEDIUM BY METHOD OF ACTIVE INTERFEROMETRY

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 61, No 6, Dec 86
(manuscript received 16 Apr 86) pp 1337-1342

[Article by Yu. A. Zimin and A. L. Volpov]

[Abstract] Synthesis of images of objects located in randomly nonhomogeneous media such as a turbulent atmosphere is considered, this case requiring not only amplitude information but also phase information encoded in the instantaneous relative location of the object as well as in the interference pattern which two coherent illuminating waves produce. Statistical characteristics of radiation passing through turbulent atmosphere. An image is synthesized on this basis by illumination of the object by two coherent light beams coming from sources with different space diversities and subsequent recording of the

integral intensity of reflected light, assuming that the object is located in the far diffraction zone relative to both sources and accounting only for phase distortions in turbulent atmosphere. First is used an aperture with a transverse dimension much smaller than the correlation radius for field phase fluctuations in the atmosphere and then an aperture with arbitrary transverse dimension. Synthesis of an image in the latter case is found to be made possible by averaging the measured quantities over the readings of field phase distortions during the probing period. References 9: 7 Russian, 2 Western.

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UDC 535.2.01

NONUNIFORMITY OF ELECTROMAGNETIC FIELD AT $\lambda = 10.6 \mu\text{m}$ WAVELENGTH INSIDE
ATMOSPHERIC AEROSOL PARTICLES

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 61, No 6, Dec 86
(manuscript received 23 Jul 85) pp 1331-1336

[Article by N. N. Belov]

[Abstract] Probing of the atmosphere with a CO_2 -laser beam ($\lambda = 10.6 \mu\text{m}$ wavelength) is considered, absorption of optical radiation and emission of heat by solid atmospheric aerosol particles being analyzed on the basis of the Mie theory. The nonuniform radial distributions of electromagnetic field intensity and heat emission intensity are determined in the approximation of geometrical optics, assuming spherical particles. Calculations are made separately for weakly absorbing and strongly absorbing substances (Al_2O_3 , ice, SiO_2 , MgO , NaCl , soot, graphite, coal), different treatment being required in each case for particles with radii smaller than the radiation wavelength ($0.02\text{--}0.1 \mu\text{m}$), for particles with radii comparable with the radiation wavelength, and for particles with radii larger than the radiation wavelength ($30\text{--}60 \mu\text{m}$). As a simplification covering the entire range is proposed focusing the radiation at the center of spherical particle, assuming smaller than critical incidence angles and selecting the Brewster angle as critical in the case of a real refractive index or the zero-refraction angle as critical in the case of a complex refractive index. Figures 2; tables 2; references 18: 10 Russian, 8 Western (3 in Russian translation).

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NEW DESCRIPTION OF LAU EFFECT BASED ON THEORY OF RASTER IMAGE FORMING PROCESS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 61, No 6, Dec 86
(manuscript received 28 Jan 86) pp 1308-1311

[Article by M. V. Shovgenyuk]

[Abstract] Formation of a high-contrast interference pattern with color fringes following Fresnel diffraction of noncoherent light successively by two identical gratings parallel one behind the other is described on the basis of the theory of raster image formation. Such a description conforms to a general relation, never before derived, for the intensity distribution under conditions of the Lau experiment. This relation, derived here with the aid of Fourier analysis and assuming a point source of noncoherent light, deals also with the fine structure of interference fringes. The corresponding Lau conditions are sufficient only in the case of precisely monochromatic light. The relation can be extended to dichromatic and polychromatic light, however, considering that the difference between wavelengths decreases as the distance between the gratings is increased. Figures 2; references 9: 2 Russian, 7 Western (1 in Russian translation).

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UDC 621.373:535+535.317.1

SELECTION OF HOLOGRAPHIC SCREEN FOR PROJECTION OF IMAGES RECONSTRUCTED BY MULTIASPECT HOLOGRAMS OF FOCUSED IMAGES

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 61, No 6, Dec 86
(manuscript received 28 May 86) pp 1320-1325

[Article by A. D. Galpern and A. A. Paramonov]

[Abstract] Recording multiaspect holograms and their copying as multiaspect holograms of focused images is considered for recording and reproducing three-dimensional images of natural objects. Projection of such images on a holographic screen requires achromatization, inasmuch as the dispersion of such multiaspect holograms causes multicolor tinting of the image when the latter is viewed by a vertically moving eye. A geometrically achromatized system has been found to produce a parasitic pattern of spots in the viewing window, evidently traceable to the holographic screen and associated with the speckle structure recorded on that screen. The feasibility of minimizing or altogether eliminating this parasitic pattern is examined by analysis of the field intensity distribution and the eye response taking into account their statistical characteristics, an image being viewed in noncoherent light. The results indicate that in the case of many brightness gradations and semitones it is preferable to select point focusing screens, to use a point source rather than a diffuse strip for recording, and to widen the viewing window by use of a long vertical strip source for reconstructing. Figures 3; references 5: 2 Russian, 3 Western (1 in Russian translation).

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CSO: 1862/106

EFFECT OF RANDOM INHOMOGENEITIES IN OPTICAL FIBER ON NULL SHIFT IN RING INTERFEROMETER

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 61, No 6, Dec 86
(manuscript received 29 Oct 85) pp 1295-1299

[Article by S. M. Kozel, V. N. Listvin, S. V. Shatalin, and R. V. Yushkaytis]

[Abstract] A ring interferometer is considered which uses single-mode fiber optics with strong linear birefringence and a wideband polychromatic radiation source for minimization of the null shift in the interference pattern. The effect of polarization anisotropy is evaluated analytically, the anisotropy parameters depending largely on the radiation wavelength and random interaction of polarization modes partly compensating their group delay. The analysis is based on the coherence matrix J for a random plane wave at the fiber exit, assuming a steady radiation source and taking into account the complete correlational structure of the radiation. The null shift is then

determined from the condition that $\frac{dt}{d\phi}\bigg|_{\phi=\phi_0} = 0$ ($\tau = \frac{\text{Sp } \hat{J}}{\text{Sp } \hat{J}_0}$ - transmission

coefficient, \hat{J}_0 - coherence matrix at the fiber entrance, ϕ - Sagnac phase shift). The effect of strong birefringence in the fiber optics is evaluated with the aid of the Jones matrix for a forward wave, disregarding anisotropy in the polarization filter and in the divider. The mean null shift is found to be determined by the orientation of the birefringence axes but not to depend on the index difference. The dispersion of the null shift is found to be determined by the degree of polarization and by the depolarization distance, the latter having been assumed to be much shorter than the fiber. The null drift, moreover, principally a consequence of the temperature dependence of the birefringence, is determined by random inhomogeneities in the fiber optics. Figures 2; references 11: 4 Russian, 7 Western.

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UDC 535.331.23+539.194

PHOTOPHYSICAL PROCESSES AND INTRAMOLECULAR CHARGE TRANSFER IN MOLECULES OF MESONITROPORPHYRINS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 61, No 6, Dec 86
(manuscript received 2 Jun 86) pp 1228-1234

[Article by S. S. Dvornikov, T. F. Kachura, V. N. Knyukshto, V. A. Kuzmitskiy, K. N. Solovyev, and I. K. Shushkevich]

[Abstract] An experimental study of photoinduced charge transfer within molecules of mono-mesonitro and trans-di-mesonitro derivatives of 1-8 octaethyl porphin (OEP), namely $H_2-\alpha$ -NO₂-OEP and $H_2-\alpha, \gamma$ -(NO₂)₂-OEP, as well as corresponding Zn complexes, also tri-mesonitro² and tetra-mesonitro derivatives was

made along with quantum-chemical calculations by the IIII Δ II/C method, for the purpose of determining the role of the NO_2 -group. Absorption, fluorescence, and phosphorescence spectra of these compounds were measured at a temperature of 77 K, with specimens in a Dewar quartz flask with a 3:5:2 mixture of diethyl ether + petroleum ether + isopropyl alcohol as solvent. The lifetime of fluorescence at 295 K was measured by the phase method with an SIM-4800 spectrofluorimeter and, lifetime longer than 1 ns, also with a PRA-3000 pulse fluorometer. As reference standard served Pd-mesoporphyrin IX in dimethyl ether. Analysis of the spectra and calculations with the oxygen atom parameter in the resonance integral $\beta_0 = -30$ eV have yielded two characteristics of electron transitions to triplet and singlet states in a molecule, namely energy (E , cm^{-1}) and charge (Q , %) transferred to the NO_2 -group in the process, also the energy of molecular orbitals depending on the dihedral angle θ between the NO_2 -group and the porphyrin ring. Calculations were made with $\theta = 0$ (maximum interaction), $\theta = 90^\circ$ (almost no change in structure of molecular levels but additional pair of intramolecular charge transfer levels), and $\theta = 45^\circ$ most suitable for comparison with experimental data. The latter reveal a departure from the Yermolayev-Sveshnikova rule $\phi_F + \phi_T = 1$, where ϕ_F and ϕ_T are the quantum yields of fluorescence and intercombinational conversion to triplet states respectively. Evidently the NO_2 -group raises the probability of nonradiative $S_1 \rightarrow S_0$ transition and thus causes the sum of these two quantum yields to become smaller than 1. The authors thank B. M. Dzhagarova and M. P. Tsvirko for assisting in measurement of the quantum yield of transition to triplet states. Figures 3; references 21: 7 Russian, 1 Polish, 13 Western.

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ELECTROLUMINESCENCE OF DIELECTRICS IN FAR OFF-EQUILIBRIUM CHARGED STATE

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 61, No 6, Dec 86
(manuscript received 5 Feb 86) pp 1271-1273

[Article by V. L. Uvarov, B. I. Moiseyenko, and G. N. Protasyuk]

[Abstract] An experiment with an optically transparent and electrically strong dielectric material was performed for a study of its electroluminescence attending formation of solitary dipole domains, an internal electric field of space charge with an intensity equal to or higher than the domain formation threshold $E_c = 5 \cdot 10^5$ V/cm being produced by charge injection. A cylindrical specimen of polymethyl methacrylate 50 mm high and 90 mm in diameter, with polished surfaces, was placed on a copper colorimeter with a hole 70 mm in diameter as window. On the opposite side the specimen was in contact with a cylinder of the same material 90 mm high and also 90 mm in diameter, serving as both light guide and sound guide. Measurements were made with an FEU-31

photomultiplier and with an acoustic transducer made of TsTS-19 piezoceramic. Charge was injected into the specimen under normal conditions in a wide 8 MeV-15 μ A electron beam from a linear accelerator. On the basis of measurements have been determined the profiles of electric field distribution and space charge concentration in the dielectric at given injection and exposure levels. While the former was found to decrease monotonically depthwise, the latter was found to peak at some depth. Into account was taken attraction of air ions from the region of electron beam passage, causing the specimen to remain electrically neutral as a whole. Oscillograms reveal a time lag of the acoustic signal behind the optical one corresponding to the time of sound pulse passage. Recombination as principal mechanism of electroluminescence is indicated by the long decay time, 2-3 μ s and thus 2-3 orders of magnitude longer than time of excitation quenching by the intracenter mechanism. Figures 3; references 9: 7 Russian, 2 Western.

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UDC 539.196.3

EFFECT OF FREQUENCY EXCHANGE ON SIGNAL IN TRANSIENT ACTIVE SPECTROSCOPY

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 61, No 6, Dec 86
(manuscript received 10 Feb 86) pp 1201-1208

[Article by D. V. Kolomoitsev and S. Yu. Nikishin]

[Abstract] A problem of transient active Raman scattering spectroscopy for nonuniformly widened transitions is analyzed, namely frequency exchange characterizing changes in the rotational states of molecules upon collision and its effect on the spectroscopy signal. The signal is described in terms of average recorded energy for the case of excitation by picosecond laser pulses with the correlation time of the noise substructure much shorter than the pulse duration, taking into account statistically independent rotational and adiabatic vibrational dephasing. A model of the Green function is constructed for a nonhomogeneous array of oscillators and on its basis are made calculations for the nonuniformly widened Q-band of molecular vibrations of nitrogen, at a temperature of 295 K under a pressure of 1 atm. The results are compared with available experimental data, for optimum matching of the adiabatic vibrational dephasing time and the correlation time for the angular moment. The results indicate that all experimental data can be interpreted in terms of rotational dephasing and frequency exchange only. The temperature dependence of the cross-section for rotationally inelastic collisions can therefore be determined from estimates of the mean time between such collisions, and this has been done covering the 25-295 K temperature range. Figures 4; references 15: 9 Russian, 6 Western (2 in Russian translation).

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SHARPENING CONTRAST IN MULTIBEAM INTERFERENCE DEVICES

Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 29, No 12, Dec 86 (manuscript received 19 Feb 86) pp 89-91

[Article by A. A. Yelisseyev, O. M. Ravodin, O. V. Ravodina, and V. V. Stenina, Siberian Institute of Engineering Physics imeni V. D. Kuznetsov, Tomsk State University]

[Abstract] It is demonstrated theoretically that placing two identical multi-beam interference devices one behind the other will sharpen the contrast. The separation between the contours of their respective reflection or transmission bands necessary for suppressing the lateral peaks is calculated by the energy method on the basis of the cross-correlation coefficient for a band sufficiently wide to include lateral peaks and a large change of that coefficient within the vicinity of the principal peak. The mismatch of the two devices can be further optimized by making it somewhat larger than theoretical when the number of interfering beams is large and peaks become densely spaced. Figures 2.

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PARAMETRIC AND RESONANCE INTERACTION OF ULTRASHORT LIGHT PULSES IN NONLINEAR MULTILEVEL MEDIUM

Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 92, No 1, Jan 87 (manuscript received 14 Feb 86) pp 46-55

[Article by A. A. Zabolotskiy, Institute of Automation and Electrometry, Siberian Department, USSR Academy of Sciences]

[Abstract] Interactions of ultrashort light pulses in nonlinear multilevel media are analyzed on the basis of a new self-consistent system of nonlinear equations integrable by the method of the inverse scattering problem. This system of equations has been formulated in the Laz representation so as to include as special cases the Maxwell-Block equations describing self-induced transparency, parametric resonance conversion of ultrashort pulses, and the equations of multiwave interaction. It is first applied here to resonance interaction of a three-wave packet and a three-level medium, including non-resonance three-wave interaction, in which case there exists a soliton solution. It is then applied to resonance interaction of a six-wave packet and a quadratically nonlinear four-level medium, with simultaneous six-wave interaction, multipole solutions corresponding here to decay of a pumping soliton into several solitons with different frequencies. The Backlund transformation relating two solutions to the new system of equations and recurrence relations which yield an infinite series of momentum integrals are derived for the case of three-wave interaction at exact resonance. The author thanks S. G. Rautian for many valuable comments. Figures 1; references 15: 12 Russian, 3 Western.

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STATE PARAMETERS OF PULSE-DISCHARGE PLASMA IN XENON-FILLED CLOSED TUBE

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 61, No 6, Dec 86
(manuscript received 16 Jul 86) pp 1192-1196

[Article by V. Ye. Gavrilov]

[Abstract] In a diagnostic study of pulse-discharge plasma in xenon flash-tubes, the state parameters of such a plasma were measured in an experiment by spectroscopic methods. Electric discharge pulses of approximately 300 μ s duration were produced from a 400-800 μ F capacitor bank through a circuit with 10-30 μ H inductance and 0.02-0.03 ohm resistance. The discharge power density in 5-25 cm long tubes with 0.5-1.5 cm inside diameters was varied over the 10^5 - 10^6 W/cm³ by varying the capacitor voltage over the 0.5-5 kV range. The optical equipment included an achromatic projecting quartz lens with a focal length of 15 cm, a DMR-4 monochromator with glass prisms, attenuating filters, and a diaphragm. This optical system had a space resolution of 0.05x0.2 mm² and a spectral resolution of 0.2-1 nm. The plasma temperature was determined from the spectral density, brightness, and absorptivity in accordance with the Kirchhoff-Planck law. The plasma density and pressure were determined in two independent ways, first on the basis of the temperature distribution and the Saha relation, assuming a uniform pressure distribution over the tube volume and a constant gas mass during measurement, then on the basis of the half-width of the spectral absorption line of hydrogen added in small amounts to xenon. The results have been used for evaluating the dependence of the plasma temperature and pressure on the density of the electric discharge current over the 0-10 kA/cm² range under initial xenon pressures of 6.7-80 kPa as well as the dependence of the plasma density and pressure on the plasma temperature, also of the plasma pressure on the electron concentration and on the discharge power. Figures 4; references 15: 12 Russian, 3 Western (1 in Russian translation).

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INSTABILITY OF BOUNDED ELECTRON BEAM IN LONGITUDINAL MAGNETIC FIELD

Moscow FIZIKA PLAZMY in Russian Vol 13, No 1, Jan 87
(manuscript received 11 Feb 86, after correction 14 May 86) pp 73-79

[Article by A. N. Mosiyuk, Institute of Physics, USSR Academy of Sciences]

[Abstract] A transversely bounded homogeneous electron beam passing through a compensating ion cloud inside a cylindrical metal tube is considered and its instability in a longitudinal magnetic field alternating at a frequency much lower than the ion-cyclotron frequency is analyzed. Calculations based on linearized equations of motion and continuity, also Poisson equation, yield the instability increment as a function of the beam current and the transverse wave number. The regions and thresholds of aperiodic and oscillatory Pierce instability, Pierce-Buneman instability, and current-convective instability have been established in the quasi-classical approximation by both analytical and numerical solution of the problems, also for a longitudinally bounded electron beam. The author thanks V. V. Vladimirov for helpful suggestions and M. A. Mukhtarov for discussion with critical comments. Figures 3; references 16: 14 Russian, 2 Western.

2415/5915
CSO: 1862/123

EFFECT OF PLASMA ROTATION IN TOKAMAK ON STABILIZING ACTION OF ELECTRICALLY CONDUCTING WALL

Moscow FIZIKA PLAZMY in Russian Vol 13, No 1, Jan 87
(manuscript received 22 Apr 86) pp 118-119

[Article by L. Ye. Zakharov and S. V. Putvinskiy, Institute of Atomic Energy imeni I. V. Kurchatov]

[Abstract] It is already known that, unlike an ideally conducting shield near the boundary of a tokamak plasma filament, a shield with finite electrical conductivity does not remove the conditions for helical instability of such a plasma but only reduces the instability increment. It is now demonstrated analytically that rotation of the plasma does not improve the stabilizing action of such a shield. The proof is based on the model of a cylindrical plasma with uniform current moving at a constant velocity in the axial direction through vacuum. The presence of a "stationary" mode causes the residual instability increment to be independent of the speed of plasma rotation and to depend only on the effective skin-effect time of the shield. References 2: 1 Russian, 1 Western.

2415/5915
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EFFECT OF PLASMA RESONANCE ON PROPERTIES OF SURFACE WAVES

Moscow FIZIKA PLAZMY in Russian Vol 13, No 1, Jan 87
(manuscript received 12 Feb 86) pp 62-65

[Article by M. I. Bakunov, V. D. Pikulin, and N. S. Stepanov, Gorkiy State University imeni N. I. Lobachevskiy]

[Abstract] Plane traveling TM-mode waves harmonic in space and in time are considered on the surface of a plasma nonhomogeneous within a $-d \leq x \leq d$ region with a cubic-law rise of the charge concentration in the vicinity of $x = 0$, of interest being the effect which resonance of such a plasma has on those waves. The problem is analyzed on the basis of the corresponding wave equation and three field equations, also the dispersion equation for the longitudinal wave number. It is demonstrated that plasma resonance occurring at a point where the concentration gradient is zero or almost zero can not only prevent propagation but also ensure existence of such surface waves with either normal or anomalous dispersion. Figures 1; references 10: all Russian.

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UDC 533.951.8

CONFINEMENT OF ENERGY IN TOKAMAK-10 PLASMA DURING ELECTRON-CYCLOTRON-RESONANCE HEATING

Moscow FIZIKA PLAZMY in Russian Vol 13, No 1, Jan 87
(manuscript received 21 Mar 86) pp 3-19

[Article by V. V. Alikayev, A. A. Bagdasarov, N. L. Vasin, Yu. V. Yesipchuk, A. Ya. Kislov, G. Ye. Notkin, and K. A. Razumova, Institute of Atomic Energy imeni I. V. Kurchatov]

[Abstract] A series of experiments with boost heating of a tokamak plasma at electron-cyclotron-resonance (ECR) frequency was performed in the T-10 facility, for a study of plasma energy confinement and its relaxation with increasing heating power. The plasma current and electron concentration were varied over wide ranges of $I_p = 100-500$ kA and $n_e = (1.0-5.5) \cdot 10^{13} \text{ cm}^{-3}$ respectively, the limiter diameter being either 34 cm or 17 cm, while the magnetic field was varied over a narrow range about the $B_T = 3$ T induction level. The booster heating power of six gyratrons was applied from the side of the weaker toroidal magnetic field, the ordinary wave and the extraordinary wave carrying approximately 70% and 30% of it respectively. This power was varied to almost four times the Joule-effect heating power, with the electron temperature at the center of the plasma filament reaching 4.2 keV and thus becoming approximately three times higher than during Joule-effect heating. Taking into account the radial profile of microwave-heat absorption in a plasma and that energy confinement is subject to different similarity laws during ECR-heating than during

Joule-effect heating, the experimental data have been analyzed and evaluated so as to reveal the dependence of the plasma energy increment and of the total plasma energy lifetime as well as of the local thermal conductivity during ECR-heating on the total input power and on the gyatron discharge parameters. The data were found to closely fit the Mukhovatov-Merezhin or neoalkator scaling in the low-current range and the Kaye-Goldston scaling in the high-current range, while indicating that confinement during ECR-heating is not an analog of L-mode confinement. The data have further yielded global characteristics of plasma energy confinement during ECR-heating and their dependence on the radial profile of power absorption. They have also revealed differences between confinement during ECR-heating and during Joule-effect heating respectively. The results are compared with those of TFTR and ASDEX experiments. An important factor on which the feasible degree of confinement depends is the "limiting" profile, apparently determined by the stability of resistive helical and ballooning modes. The authors thank B. B. Kadomtsev and V. S. Strelkov for interest and many discussions, K. N. Tarasyan and S. V. Neudachin as well as all the T-10 personnel for assistance. Figures 16; tables 2; references 12: 1 Russian, 11 Western.

2415/5915
CSO: 1862/123

LOW-FREQUENCY OSCILLATIONS IN NONIDEAL PLASMA

Leningrad PISMA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 13, No 2, 26 Jan 87 (manuscript received 31 Jul 86) pp 90-94

[Article by M. A. Berkovskiy, A. A. Valuyev, and Yu. K. Kurilenkov, Institute of High Temperatures, USSR Academy of Sciences, Moscow]

[Abstract] The spectrum and the characteristics of low-frequency oscillations in a homogeneous and isotropic nonideal plasma are examined, the nonideality parameter being defined as $\gamma = e^2 n^{1/3} / T_{\kappa} \lambda$ ($n = n_e + n_i$, n_e - electron concentration, n_i - ion concentration, T - temperature). Ion-acoustic oscillations in a nonisothermal plasma with $T_e \gg T_i$ are considered, their decay in an isothermal plasma being the result of energy dissipation in the space charge by nonresonant collisions rather than a resonant collisionless mechanism and also by principally electronic heat conduction. Plain acoustic oscillations can also occur at frequencies below the frequency of ion-ion collisions. The frequency of ion-electron collisions in a nonideal plasma is high and such collisions are significant under isothermal conditions with $T_e = T_i$. Collective oscillations in a nonideal plasma are characterized by a large amplitude even under equilibrium conditions. The authors thank B. A. Alterkop and A. A. Rukhadze for helpful discussions. References 4: 1 Russian, 3 Western.

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SELF-ALIGNMENT OF IONS DRIFTING IN PLASMA

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 45, No 1, 10 Jan 87 (manuscript received 28 Oct 86) pp 15-17

[Article by S. A. Kazantsev, A. G. Petrashen, N. T. Polezhayeva, V. N. Rebane,
and T. K. Rebane, Leningrad State University imeni A. A. Zhdanov]

[Abstract] The hypothesis that drift of ions in a plasma causes their spontaneous alignment with a quadrupole orientation of their angular momentum was confirmed in an experiment with ionization of argon in a 100-400 V hollow-cathode discharge tube 5 cm long and 3 cm in diameter. Intensities I_z and I_y of spontaneously emitted radiation linearly polarized parallel (I_z) and perpendicularly (I_y) to the drift axis respectively, at various lines in the spectra of atomic and ionized argon, were recorded along the symmetry axis of the cathode with a Hanle polarization spectrometer. The difference $I_z - I_y$ served as measure of self-alignment of excited states, the sum $I_z + I_y$ being proportional to the populations of these states. Distinct difference signals corresponding to the fine structure were recorded within the narrow low-pressure range of 0.1-0.5 torr at discharge currents of 10-60 mA. A comparison of difference signals from atomic argon and from weakly ionized argon proves the drift hypothesis of self-alignment most directly. The experimental data confirm also other predictions, namely that self-alignment of ions is closely associated with collisional mixing of half-levels in the fine structure of ions and that the self-alignment signal originates from a deviation of the ratio N_1/N_2 of respective half-level populations from the ratio g_1/g_2 of their statistical weights. Figures 3; references: 2 Russian.

2415/5915

CSO: 1862/124

NUCLEAR ORIENTATION AND MÖSSBAUER EFFECT AT INFRALOW TEMPERATURES

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 50,
No 12, Dec 86 pp 2413-2424

[Article by V. A. Andrianov, M. G. Kozin, A. Yu. Pentin, and V. S. Shpinel,
Scientific Research Institute of Nuclear Physics, Moscow State University
imeni M. V. Lomonosov]

[Abstract] Combining the method of nuclear orientation at infralow temperatures with the method of nuclear-magnetic resonance or with the Mössbauer effect is considered for more extensive and precise study of hyperfine interactions in metals. The method of nuclear orientation is based on the angular intensity distribution of radiation from oriented nuclei, conventionally expressed in the form of a Legendre polynomial series and an isotropic one corresponding to non-oriented nuclei at high temperatures. Magnetic hyperfine interaction and electric hyperfine interaction are studied experimentally with radioactive nuclei implanted respectively in a ferromagnetic matrix where they produce strong hyperfine magnetic fields or in a single crystal where they produce large electric field gradients. Infralow temperatures for such experiments are attained in a refrigerator with ^3He - ^4He solution or in a cryostat with adiabatic demagnetization. Such experiments yield only relative data, namely the ratio of hyperfine interaction energy to thermal energy, inasmuch as the Boltzmann distribution determined the orientation of nuclei. The method has been used for measuring the characteristic time of nuclear relaxation and the kinetics of anisotropy decay in the angular distribution of radiation intensity, taking into account the effect of processes at intermediate nuclear levels and attendant static perturbations of nuclear orientation owing to hyperfine interaction at such levels. Combining the method of nuclear orientation with the NMR method improves the accuracy of measurements appreciably, with an error not larger than 0.01-0.1%. Combining it with the Mössbauer effect facilitates precise measurements on parent and daughter nuclei in decay processes, also determination of the relative signs of hyperfine interaction in each nucleus and thus of the high-intensity components in the spectrum. Hyperfine interaction in dilute magnetic alloys Pd+ Fe and Pd+ Co, with "giant" moments, has been studied on the basis of the Mössbauer effect on oriented nuclei. Static perturbations occur in this method too, but distortions due to interference are small and the scheme with "level mixing resonance" is most expedient for their detection. Figures 15; references 33: 5 Russian, 1 Polish, 27 Western (1 in Russian translation).

2415/5915
CSO: 1862/104

STUDY OF STRUCTURAL DEFECTS IN FERROMAGNETIC METALS BY METHOD OF MUON SPIN ROTATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 50, No 12, Dec 86 pp 2345-2347

[Article by V. P. Melnichuk, V. Yu. Miloserdin, A. Yu. Mishchenko, and S. B. Karpov]

[Abstract] The feasibility of using positively charged muons for studying structural defects in ferromagnetic metals is examined by rigorous analysis of muon polarization kinetics according to a theory of muon depolarization upon capture, this theory being based on the premise that a positively charged muon implanted in a ferromagnetic metal can be captured by a defect and that it becomes thermalized within a time much shorter than the mean time to its capture. The possibility of nondestructive structural examination for defects diagnostics by this method is demonstrated mathematically by solution of the corresponding system of two equations for the time derivatives of muon polarization before and after capture respectively. The probability of muon escape from a defect within a unit of time is first assumed to be zero and then allowed not to be zero but much lower than the probability of muon capture within a unit of time. The solution and the precession characteristics of the muon polarization components indicate that the μ SR (muon spin rotation) method is favorably insensitive to the presence of interstitial intrinsic metal atoms, inasmuch as such an atom repels a muon by the Coulomb interaction mechanism. The method is applicable to study of linear dislocations, as demonstrated on the example of an iron crystal with the magnetization vector along the $\langle 100 \rangle$ axis and the Burgers vector along the $\langle 111 \rangle$ axis. It is also applicable to study of defect clusters and Frenkel defects. References 4: 2 Russian, 2 Western (1 in Russian translation).

2415/5915
CSO: 1862/104

TRANSITION TO COMBUSTION OF CONDENSED SUBSTANCE UNDER IMPINGING PULSE OF LUMINOUS RADIATION FLUX

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 22, No 6, Nov-Dec 86 (manuscript received 5 May 85) pp 88-93

[Article by S. I. Baklan, V. N. Vilyunov, and I. G. Dik, Tomsk]

[Abstract] Ignition of a condensed substance by a pulse of thermal flux and subsequent transition to combustion are analyzed on the basis of one mathematical model, namely the equation of heat conduction for a condensed substance in accordance with Bouguer's law with inclusion of a term which accounts for the effect of the exothermic chemical reaction following the pulse action. The rate of heat generation by this reaction is assumed to be proportional to the

rate of that reaction, which is assumed to vary according to the relation

$\partial \eta / \partial t = (1-\eta) \bar{z} e^{-E/kT}$. The equation is solved for adiabatic boundary conditions at the surface of the condensed phase and at infinity, which corresponds to no participation of the gaseous phase in the transition process. The surface of the condensed phase remains stationary until the reaction front reaches a certain critical depth. Calculations for a translucent substance and a square pulse of impinging luminous radiation have yielded the temperature transient $T_s(t)$ at the surface, based on the dynamics of the temperature field $T(x,t)$ and including the time in which the surface reaches the temperature of adiabatic combustion, also the ignition stability limit in terms of the time versus radiation intensity within the impinging pulse, the critical time for overirradiation, and the velocity of the moving surface as a function of time after the critical depth of reaction has been reached. Figures 5; references 11: 10 Russian, 1 Western.

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UDC 621.378.32:534.222.2

DEPENDENCE OF ACOUSTICAL CHARACTERISTICS OF LASER-INDUCED BREAKDOWN IN DIELECTRIC MATERIALS ON SHAPE OF INELASTIC REGION

Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 29, No 11, Nov 86 (manuscript received 11 Jun 85) pp 105-108

[Article by A. Yu. Ivanov and E. A. Manykin, Grodno State University]

[Abstract] Generation of acoustic waves in a transparent dielectric material following its breakdown by a laser beam is analyzed theoretically, taking into consideration the real ellipsoidal rather than ideal spherical shape of the inelastic region and its prolateness in the direction of the laser beam. The boundary conditions at the surface of this region are stipulated in terms of zero shear strains and pressure or normal stress decreasing exponentially with time over duration of the laser pulse, assuming that the surfaces of the specimen are so far from the inelastic region inside as to have a negligible effect on the process. The corresponding wave equations for the displacement vector are solved in Legendre series, after this vector has been resolved into longitudinal components which is the gradient of a scalar potential and a transverse component which is the curl of a vector potential. In an ellipsoidal system of coordinates each term of the series is the product of two Legendre functions, with a coefficient, one of the first kind of a circular trigonometric argument and one of the second kind of a hyperbolic trigonometric argument. At far distance from the inelastic region the solution simplifies, inasmuch as shear waves do not reach the detector before longitudinal waves have already been recorded. Figures 2; references 9: 8 Russian, 1 Western.

2415/5915
CSO: 1862/116

ELECTRON STRUCTURE AND OPTICAL SPECTRA OF HEAVY ALKALI METALS UNDER HIGH PRESSURE

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 44, No 11, 10 Dec 86 (manuscript received 5 Nov 86) pp 535-537

[Article by I. I. Mazin, Ye. G. Maksimov, S. N. Rashkeyev, and Yu. A. Uspenskiy, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences]

[Abstract] Changes in the electron structure of Rb and Cs under high pressure are described on the basis of analysis of their optical spectra and pertinent microeffect calculations. Transfer of electrons from the 6s band to the 5d band is the cause of macroeffects such as volume reduction, this process being completed in Rb under 500 kbar and in more compressible Cs under 150 kbar. Evidence of changes in the electron structure is provided by the frequency dependence of the complex dielectric permittivity and of the reflection coefficient, the latter being an integral characteristic and thus not yielding information directly. An analysis of the data has revealed that electron states near the edge of the Brillouin zone are principal contributors to the interband electron transfer at the $\omega \approx 2$ eV energy level. The authors thank S. M. Stishov for discussing problems relevant to high-pressure physics of alkali metals. Figures 3; references 9: 3 Russian, 6 Western.

2415/5915
CSO: 1862/108

RYDBERG ATOM ON SURFACE OF LIQUID HELIUM

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 44, No 11, 10 Dec 86 (manuscript received 5 Nov 86) pp 501-504

[Article by P. B. Lerner and I. M. Sokolov, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences]

[Abstract] The problem of retaining highly excited atoms in sufficiently large concentration by cooling is analyzed, considering that the electron shell of such an atom is not rigid and therefore does not resist its attraction to the cooling surface as a result of dipole interaction with its image. The energy of resulting strong adsorption of a hydrogen proton by the surface of liquid helium is estimated, assuming adiabatic adsorption, on the basis of known 1.85 eV bond energy of a HeH^+ complex ion forming in the process and known image potential $U(z) = -Qe^2/z$ (e - charge of electron, z - distance from surface, $Q = 6.9 \cdot 10^{-3}$ for ^4He) describing electron-dielectric interaction. Calculations involve solution of the corresponding Schrödinger equation for the appropriate boundary condition at the surface, which can be done by separation of variables in ellipsoidal coordinates. The electron state and its changes in the process are characterized by three quantum numbers: magnetic number and two numbers corresponding to the numbers of zeros of the wave function along each of the

two ellipsoidal coordinates. The authors thank A. V. Babkin, Yu. S. Barash, L. V. Keldysh, V. I. Panov, A. A. Sobyenin for helpful discussions and Yu. Ye. Lozovik for pointing out that J. Chalupa has dealt with the problem of classifying excited states of the surface of liquid helium. Figures 1; references 8: 5 Russian, 3 Western (1 in Russian translation).

2415/5915
CSO: 1862/108

DEVELOPMENT OF CRACK UNDER PERIODICALLY PULSED LASER RADIATION

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNIЧЕСКОY FIZIKI in Russian No 6(160), Nov-Dec 86 (manuscript received 24 Sep 85) pp 108-110

[Article by G. Ya. Glauberman, S. V. Kondrashov, N. F. Pilipetskiy, S. Yu. Savanin, and V. V. Shkunov, Moscow]

[Abstract] An experimental study of laser-induced crack development in polymer materials was made, with a periodically pulsed low-power LTIPCh-8 laser irradiating oriented polymethyl methacrylate. The laser radiation was focused on specimens already containing microcracks in pulses of $6 \cdot 10^{-2}$ W average power at a repetition rate of 50 Hz. The crack growth was tracked by means of high-speed photography. Data on the absorption wavelength and the crack diameter as functions of time indicate that they increase with time linearly and according to a half-power law respectively. These results fit a theoretical interpretation on the basis of laser energy-pulse characteristics and gas thermodynamics, assuming that crack growth is an isothermal process and that an ideal gas is generated in the crack space with no relaxation or change in the number of gas molecules during intervals between laser pulses. Mathematical analysis leads to a linear first-order differential equation of cracking kinetics whose solution confirms the experimental results. Experiments performed by Yu. V. Sidornyy indicate that a nearly ideal gas is generated in cracks during irradiation in periodic pulses. Figures 3; references 11: 9 Russian, 2 Western (both in Russian translation).

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CSO: 1862/126

EXPERIMENTAL OBSERVATION OF PHOTORESONANCE OF ELECTRONS LOCALIZED ABOVE SURFACE OF SOLID HYDROGEN

Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 92, No 1, Jan 87 (manuscript received 21 Jul 86) pp 339-349

[Article by V. V. Zavyalov and I. I. Smolyaninov, Institute of Problems in Physics, USSR Academy of Sciences]

[Abstract] Resonant absorption of light corresponding to $1 \rightarrow 2$ and $1 \rightarrow 3$ transitions of electrons localized above the surface of solid hydrogen was observed in an experiment with an H_2 crystal and laser spectroscopy. An optically transparent H_2 crystal was grown from the liquid phase in a vertical cylindrical chamber consisting of a 0.2 mm thick tube of stainless steel, a heavy copper cover, and a monocrystalline sapphire bottom 35 mm in diameter retained by a 5 mm thick copper hoop. Optical windows in the chamber wall were made of monocrystalline quartz. The cover was attached to a helium cryostat through an automatic thermal switch consisting of three coaxial copper cylinders enclosed by a thin hermetic shell of stainless steel. A uniform electric field pulling electrons to the solid hydrogen surface was produced by two electrodes, a lower aluminum electrode vacuum-deposited on the sapphire surface at a potential adjustable from 0 to 4 kV and an upper electrode at zero potential 2.3 mm above the sapphire surface. The potential at the lower electrode was modulated to a depth sufficient for measurements at a frequency of 8 kHz. Free electrons were injected onto the solid hydrogen surface under a varying voltage and under a varying pressure, the latter sufficiently high to preclude formation of a stable bound charge removable only by melting the crystal. A gas-discharge laser on water vapor was used for spectroscopy at wavelength $\lambda = 78.4, 79.1, 118.6 \mu m$ (H_2O) and $\lambda = 84.3, 107.7 \mu m$ (D_2O), tunable by regulation of the resonator length. Linear polarization of the laser beam was attained by stretching a 20 μm thick copper filament across the resonator. The laser beam was modulated at an acoustic frequency over the 0.01-5% range, for calibration, by modulation of the discharge current. The noise component was reduced to 0.05% by adjustment of the ratio of components in the gas mixtures $H_2O + H_2 + He$ and $D_2O + D_2 + He$. The probing laser beam was focused or deflected by means of two achromatic polyethylene lenses, one with a focal length of 29 cm on the axis and one with a focal length of 10 cm off the axis. Photoresonance corresponding to $1 \rightarrow 3$ and $1 \rightarrow 2$ transitions was recorded successively as the voltage increased, the amplitude of the photo-resonance signals depending on the direction of the polarization vector of incident resonance radiation and becoming maximum with the vector of the electromagnetic wave normal to the solid hydrogen surface. The electric field intensity necessary for photoresonant $1 \rightarrow 2$ transition was found to increase, less than linearly, with increasing pressure above the solid hydrogen surface. The frequencies of both transitions were found to increase linearly with increasing electric field intensity. The resonance line width of $1 \rightarrow 2$ transition was found to increase with increasing H_2 -vapor or D_2 -vapor pressure. These results are explained in terms of "quantum refraction" (multiple scattering). Extrapolation of the transition frequency to zero electric field intensity and its linear decrease with increasing concentration of H_2 molecules in gaseous phase, with a correction for the temperature

dependence of that concentration and thus of the dielectric permittivity of solid hydrogen, yield a $1 \rightarrow 2$ transition frequency of 3.15 ± 0.05 THz and a potential barrier for electrons on a solid hydrogen surface of 3.5 ± 0.3 eV. The authors thank A. S. Borovik-Romanov for interest, M. S. Khaykin for formulating the problem, V. S. Edelman and Ye. P. Bashkin for helpful discussions. Figures 9; references 19: 10 Russian, 9 Western (1 in Russian translation).

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ANOMALIES IN ELECTROMAGNETIC ABSORPTION OF CIRCULARLY POLARIZED ULTRASONIC WAVES BY TUNGSTEN WITHIN DOPPLER-SHIFTED CYCLOTRON RESONANCE RANGE

Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 92, No 1, Jan 87 (manuscript received 13 Jun 86) pp 208-220

[Article by V. V. Gudkov and I. V. Zhevstovskikh, Institute of Metal Physics, Ural Science Center, USSR Academy of Sciences]

[Abstract] Electromagnetic absorption of circularly polarized ultrasonic waves by tungsten is analyzed theoretically on the basis of new experimental evidence about anomalies in the dependence of the absorption coefficient on the magnetic field intensity within the cyclotron range, these anomalies being related to a Doppler shift, and on the basis of more precise data pertaining to the resonance field intensity within the Doppler-phonon resonance range. Measurements were made on two cylindrical tungsten specimens of the same diameter 10 mm each but different length 4.57 mm and 2.89 mm respectively, at temperatures of 4.2 K and 1.8 K, with a piezoelectric transducer in a pulse-phase sensitive acoustic bridge tunable over the 64-262 MHz frequency range. Interpretation of the results based the electron sheet of the Fermi-surface model and determination of the nonlocal-conductivity tensor with circular components lead to the conclusion that Doppler-shifted cyclotron resonance of electrons with maximum momentum in tungsten occurs in the form of a quasi-wave Doppler-phonon resonance in (-) polarization and two quasi-three-dimensionals (pseudo-Doppler-phonon) resonances in different circular polarizations. These resonances, manifesting a field interaction of the elastic subsystem and conduction electrons, appear as a main peak and two companion peaks on the absorption curves. The authors thank R. Sh. Nasyrov for supplying the tungsten specimens. Figures 7; references 14: 9 Russian, 5 Western.

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EQUIVALENCE PRINCIPLE AND ZERO-POINT FIELD FLUCTUATIONS

Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 92, No 1, Jan 87 (manuscript received 30 Jul 86) pp 20-27

[Article by L. P. Grishchuk, Ya. B. Zeldovich, and L. V. Rozhanskiy, Institute of Problems in Physics, USSR Academy of Sciences]

[Abstract] Einstein's equivalence principle is applied to an accelerated Rindler quantum detector in the Minkovski space and in the gravitational field of a static massive body, or of an eternal black hole. Including "zero point" field fluctuations is shown not to violate this principle. The behavior of such a detector will, therefore, not indicate whether it is located in a uniform gravitational field or moves at a constant acceleration in the Minkovski space. In the field of a static body, not of a black hole, a Minkovski vacuum appears to such a detector as a multiparticle state. Nonuniformity of a spherisymmetric gravitational field is assumed not to detract from the applicability of the equivalence principle, inasmuch as increasing the gravitational radius infinitely with the acceleration of gravity held constant will degenerate such a field to a uniform one. There exist massive bodies such that the temperature of a detector on their surface becomes zero and the equivalence principle applies to a detector resting on their surface. The authors thank V. L. Ginzburg, K. S. Torn, and V. P. Frolov for discussion. References 12: 2 Russian, 10 Western (1 in Russian translation).

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UDC 539.292

STUDIES OF TUNNELING IN METALS UNDER HIGH PRESSURE

Moscow USPEKHI FIZICHESKIKH NAUK in Russian Vol 151, No 1, Jan 87 pp 31-66

[Article by V. M. Svistunov, M. A. Belogolovskiy, and O. I. Chernyak, Donetsk Institute of Engineering Physics, UkSSR Academy of Sciences]

[Abstract] Fundamental concepts about tunneling in metal-insulator-metal structures and the theory of tunnel junctions are reviewed, including the pressure dependence of their current-voltage characteristic and barrier properties, as are also known techniques of high-pressure and low-temperature experiments. Superconductivity is of particular interest and tunnel spectroscopy has been found to be an effective method of not only measuring the energy gap but also analyzing the vibration spectrum in a crystal lattice and the electron-phonon interaction. Separately treated are, because of fundamental differences in the pressure dependence, nontransition metals, Nb and Ta, and La. Calculation of the superconducting transition temperature for a given metal on the basis of exact relations with the aid of tunnel-experiment data on the electron-phonon interaction is explained, as is verification of those data on the basis of the tunnel density of states at energy levels above the phonon

spectrum of a given metal. A great deal of interest is shown in binary systems with compositions near the phase equilibrium boundary, attainable by pressure and impurity control. Such systems are Pb-Bi, Bi-Tl, In-Sn. Electron spectroscopy has been found to be an effective method of measuring dimensional effects, namely the quantum dimensional effect and the A.F. Andreyev reflection of electrons in thin metal films. The authors thank N. B. Brandt for helpful discussions on all aspects of this review. Figures 25; tables 4; references 143: 65 Russian, 68 Western (9 in Russian translation).

2415/5915

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MODEL OF EARLIER STAGE OF UNIVERSE'S EVOLUTION

Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 29, No 11, Nov 86 (manuscript received 7 Sep 84) pp 54-58

[Article by K. A. Bronnikov and V. N. Melnikov, All-Union Scientific Research Center for ??]

[Abstract] A scenario of universe's evolution has been proposed in 1978 on the basis of an open nonsingular model symmetric in time and consisting of four stages: 1) spontaneous breaking of the conformal symmetry in unified theories of the Weinberg-Salam type with gravitational background, assuming that only a conformal Higgs field and a gravitational field have nonzero averages in vacuum, 2) spontaneous breaking of the gauge symmetry of a Higgs field in a gravitational field, 3) generation of particles in a nonsteady gravitational field, 4) variation of the effective gravitational coupling. The model is initially "cold" and then becomes "hot" as particles are generated or phase transition occurs. This model has been constructed on the premise that the Einstein equations with a quantum average energy-momentum tensor of physical fields in the semiclassical theory of gravitation are valid. That tensor for a vacuum-dominated isotropic universe contains a cosmological constant based on quantum gravitational effects and/or on a Grand Unified Theory, or on torsional effects, a component accounting for polarization of vacuum in any free massless conformal-invariant field, and a vacuum average complex conformal scalar field. The dynamics of this model and the corresponding earlier stage of universe's evolution are determined by the time term in the Einstein equations, analysis and solution of which in accordance with the proposed model requiring that deviation of the scalar field from classical and a possible attendant effect on the polarization of vacuum be taken into account. The essential underlying feature of this model is the concept of universe's evolution from a perfect vacuum and thus a cold state with subsequent expansion from a nonsingular state and expansion implied by the cosmological constant. References 20: 10 Russian, 1 East German, 9 Western.

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CSO: 1862/116

EVOLUTION OF PERTURBATIONS IN EXPANDING UNIVERSE

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 44, No 11, 10 Dec 86 (manuscript received 2 Oct 86) pp 481-483

[Article by A. A. Kofman, Institute of Astrophysics and Atmospheric Physics, ESSR Academy of Sciences, and V. F. Mukhanov, Institute of Nuclear Research, USSR Academy of Sciences]

[Abstract] The behavior of perturbations during evolution of the universe, particularly in its expanding stage, is analyzed on the basis of the gravitation theory with total action and inclusion of higher-order derivatives. Using the metrics of the flat homogeneous and isotropic cosmological model with small scalar perturbations for the relativistic gauge potential, a system of two equations of perturbations differential with respect to conformal time is derived from the system of corresponding two Einstein equations. They are then reduced to a single second-order differential equation in a new variable. This equation is solved asymptotically. Considering that the large class of solutions to the Einstein equations for the quiescent phonon model includes the asymptotic quasi-deSitter mode of evolution, the solution is extended to the subsequent scalar stage. Perturbations, conformally plane in the quasi-deSitter stage, are found to become conformally Newtonian upon transition to the scalar stage and to build up to the galactic scale while shifting from the short-wave mode to the long-wave mode. The amplification factor $3.6H^2/M^2$ is constrained by $H \cdot 5 \cdot 10^{13}$ GeV and $M \cdot 10^{+13}$ GeV. References 15: 6 Russian, 9 Western.

2415/5915
CSO: 1862/108

GRAVITATIONAL INTERACTION OF MASSLESS FIELDS WITH HIGHER SPINS ($s > 2$)

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 44, No 11, 10 Dec 86 (manuscript received 22 Oct 86) pp 484-488

[Article by M. A. Vasilyev and Ye. S. Fradkin, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences]

[Abstract] Massless fields with higher spins ($s > 2$) and the problem of consistently including their gravitational interaction are considered, using a description of these fields in a two-dimensional and anti-deSitter space. With the aid of an $N = 1$ superalgebra for higher spins, it is demonstrated that consistent gravitational interaction of such massless fields exists at least in the first nontrivial order. Using the explicit invariant action S in generalized coordinates for description of spin dynamics, the first variation δS is shown to be zero by virtue of two earlier proposed relations and upon appropriate transformation with specially selected coefficients. This action together with those two relations is accordingly found to consistently describe

the dynamics of all massless fields with spins $s \geq 3/2$ in the cubic approximation, involving only two independent constants: the gravitational constant and the cosmological one. References 19: 3 Russian, 16 Western (1 in Russian translation).

2415/5915

CSO: 1862/108

QUANTUM MODEL OF TECHNICOLOR WITH COMPOUND GAUGE BOSONS

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 44, No 11, 10 Dec 86 (manuscript received 24 Oct 86) pp 491-493

[Article by Yu. V. Novozhilov, Leningrad State University imeni A. A. Zhdanov]

[Abstract] A quantum model of technicolor is proposed on the basis of the Weinberg-Salam-Glashow electroweak interaction theory where all bosons are compound ones and which includes several new bosons existing by virtue of the model's group structure. The kinematic gauge potential is constructed with use of the technifermion Lagrangian and the quantum functional, for inclusion of gauge fields in the model, considering that the direction of Abelian electromagnetic rotation in the techni-isospin space is identical to the direction of the technipion field. The theory, according to this model, predicts existence of massive nongauge vector particles such as an isotriplet and an isosinglet with weak hypercharge, not necessarily directly interacting with leptons and quarks. References 6: 2 Russian, 4 Western.

2415/5915

CSO: 1862/108

INCLUSIVE SPECTRA OF SECONDARY PARTICLES PRODUCED AT NUCLEAR TARGETS ACCORDING TO QUARK-GLUON STRING MODEL AND THEIR SENSITIVITY TO PRODUCTION MECHANISM

Moscow YADERNAYA FIZIKA in Russian Vol 45, No 1, Jan 87 (manuscript received 22 Jan 86) pp 223-233

[Article by Yu. M. Shabelskiy, Leningrad Institute of Nuclear Physics, USSR Academy of Sciences]

[Abstract] The model of quark-gluon strings, based on $1/N$ -expansion in quantum chromodynamics theory, is used for calculating inclusive spectra of secondary particles produced in hadron-nuclear collisions. The distribution of quarks in colliding hadrons as well as the fragmentation of quarks and diquarks into secondary hadrons are defined in corresponding Regge asymptotic form, but also exactly satisfy all three laws of conservation pertaining to energy, electric charge, and baryonic charge respectively. The cross-sections for interaction of an impinging hadron and a nuclear target is determined, taking into account

possible slitting of one or several pomerons in each hN-interaction segment or slitting between pomerons on the cylindrical diagram of elastic or inelastic pp-scattering. The dependence of inclusive spectra on the atomic mass number according to this model is compared with that dependence according to the quasinuclear-quark model, which reveals sensitivity of these spectra to the mechanism of particle production. The quark-gluon string model predicts violation of Feynman scaling in the case of superhigh hadron-nuclear collision, as indicated by data on collision of protons or π^- -mesons with hydrogen atoms ($A = 1$) and with nitrogen ($A = 14$) or lead ($A = 207$) nuclei at energy levels of 10^3 - 10^7 GeV. The author thanks A. B. Kaydalov and K. A. Ter-Martirosyan for helpful discussions. Figures 8; tables 1; references 40: 20 Russian, 20 Western.

2415/5915
CSO: 1862/117

INTERACTION OF SOLITONS IN SKYRME MODEL

Moscow YADERNAYA FIZIKA in Russian Vol 45, No 1, Jan 87
(manuscript received 21 Mar 86) pp 165-168

[Article by S. V. Zenkin, V. B. Kopelovich, and B. Ye. Shtern, Institute of Nuclear Research, USSR Academy of Sciences]

[Abstract] Characteristics of spherisymmetric solitons with a topological baryon number $B = 2$ are evaluated on the basis of the $SU(2)$ Skyrme model in the quasi-classical approximation, considering that fields in which the energy functional has minima correspond to quasi-steady states and that under additional constraints the surface of these minima determines the static interactions in such a system. Existence of stable axisymmetric states, specifically states with mirror symmetry, is established and the interaction energy is calculated for two identical solitons with $B = 1$ from the Lagrangian only, while spherisymmetric configurations with $B \geq 2$ are found to be classically unstable under axisymmetric perturbations. The authors thank V. M. Lobashev for support and V. A. Rubakov for helpful discussions, also I. R. Kozhevnikov and Yu. P. Rybakov for interest. In addition, V. B. Kopelovich thanks I. M. Narodetskiy for discussing some of the problems. Figures 3; references: 9 Western.

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POSSIBLE NONWEAK NEUTRINO-NEUTRINO INTERACTIONS

Moscow YADERNAYA FIZIKA in Russian Vol 45, No 1, Jan 87
(manuscript received 28 Apr 86) pp 158-164

[Article by L. B. Okun, Institute of Theoretical and Experimental Physics,
State Control Institute of Atomic Energy]

[Abstract] The possibility of extending the standard electroweak interaction theory so as to account for possible strong four-fermion neutrino-neutrino interactions without breaking the renormizability of that theory is examined on the basis of a model with a scalar isosinglet boson. As examples are considered weak interactions of right neutrinos in decay of a Z-boson with attendant interaction of left neutrinos, $f(\bar{e}_{LR} + \bar{e}_{RL})\phi$ -interaction resulting in an electron and muon with anomalous magnetic moment each or contributing the sum of a monopole moment and an anapole moment at the electron vertex, exchange of two ϕ -bosons, annihilation of e^+e^- into two ϕ -bosons, decays of a W-boson and of a Z-boson with corrections to their widths as well as to both ϕ and $\sin^2\theta_W$ parameters, and decays of a π -meson and of a K-meson. The author thanks M. B. Voloshin, A. Yu. Morozov, V. A. Novikov, B. M. Pontecorvo, and M. A. Shifman for many discussions and helpful comments, but especially A. A. Gerasimov for detecting errors in some coefficients prior to publication. Figures 10; references 14: 3 Russian, 11 Western.

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DIFFICULTIES IN INTERPRETATION OF UNDERGROUND MUONS FROM CYGNUS X-3

Moscow YADERNAYA FIZIKA in Russian Vol 45, No 1, Jan 87
(manuscript received 5 Feb 86) pp 132-143

[Article by V. S. Berezinskiy, Institute of Nuclear Research, USSR Academy of Sciences, Moscow, B. L. Ioffe, Institute of Theoretical and Experimental Physics, State Control Institute of Atomic Energy, and J. Ellis, CERN, Geneva (Switzerland)]

[Abstract] Interpretation of high-energy radiation from Cygnus X-3 recorded on the basis of wide atmospheric showers and underground muons as γ -radiation is problematic for four reasons. Showers produced by γ -quanta should have a lower muon content than showers produced by hadrons. High-energy quanta are absorbed by 2.7 K relic radiation as a result of the $\gamma + \gamma_{rel} \rightarrow e^+ + e^-$ process. An underground muon flux depends strongly on the zenith angle. Underground muons are observed within a solid angle wider than the angle resolution of the detector: within $10^\circ \times 10^\circ$ in the NUSEX experiment with $\delta\theta \leq 1^\circ$ resolution or within $3^\circ \times 3^\circ$ in the SOUDAN experiment with $\delta\theta \sim 1^\circ$ resolution. An attempt to interpret the

underground muon flux from Cygnus X-3 in term of new particles, cygnets, is subject to constraints on four properties of primary particles coming from Cygnus X-3: lifetime, mass, electric charge, and angle of scattering by the interstellar medium. Expectation of cygnets on the basis of an accelerated laboratory experiment such as the beam-dump experiment need not contradict the NUSEX data, assuming either that a cygnet is produced by pp-collision not directly but in the decay of another particle II with an insufficiently long lifetime or that only high-energy (10^4 - 10^5 GeV) cygnets are produced on Cygnus X-3 and interact with nucleons so as to produce 100-200 GeV muons. The cross-sections for cygnet production are also subject to constraints. Those for production in the $pp \rightarrow CX$ reaction can be established by ignoring NUSEX data on the angular distribution of underground muons and considering range of $\sigma(CN \rightarrow \mu X)$ from $\sigma_{CN} \gtrsim 1$ b and $\sigma_{CN} \gtrsim 1$ mb to $\sigma_{CN} \sim 100$ μ b and $\sigma_{CN} \sim 1$ μ b. An analysis of σ_{CN} within each range and of the implications indicates that only $\sigma_{CN} = 2$ -10 μ b is consistent with results of the NUSEX experiment and should be expected in the beam-drop experiment, in a collider, or in special accelerated experiments with energy \sqrt{s} within the 100-1000 GeV range. The authors thank M. V. Voloshin and L. B. Okun for helpful discussions. Figures 2; references 45: 9 Russian, 36 Western.

2415/5915
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TRANSVERSE-MOMENTUM DISTRIBUTIONS AND AZIMUTHAL CORRELATIONS IN INCLUSIVE K^+p -REACTIONS AT 32 GeV/s

Moscow YADERNAYA FIZIKA in Russian Vol 45, No 1, Jan 87
[manuscript received 18 Mar 86) pp 110-116

[Article by A. G. Tomaradze, Institute of High-Energy Physics, Tbilisi State University, V. A. Uvarov and P. V. Shlyapnikov, Institute of High-Energy Physics, Serpukhov]

[Abstract] Experimental data on the cross-sections for all inclusive one-particle and two-particle K^+p -reactions at 32 GeV/s are analyzed according to two modifications of the Lund-Monte Carlo quark-fragmentation model, for a determination of transverse-momentum distributions and azimuthal correlations. In the LMCl modification σ_p has been increased to 0.62 GeV/s. In the LMC2 modification σ_p remains 0.44 GeV/s, but there has been added a random rotation of the K^+ -meson string relative to the collision line through an angle determined by the $d\sigma/dp_T \sim e^{-\alpha p_T^2}$ distribution with $\alpha = 4$ (GeV) $^{-2}$ and p_T denoting the resultant transverse momentum of the string. Azimuthal correlations in two-particle reactions are established in terms of the angle between the transverse momentum vectors of secondary particles, using an appropriately defined

asymmetry parameter, and they reveal a local compensation of transverse momenta of particles produced from the same sea quark-antiquark pair. Only the LMC2 model yields a fair or close agreement with experimental data obtained in the "Mirabel" chamber at the Institute of High-Energy Physics. Figures 1; tables 4; references 21: 6 Russian, 15 Western.

2415/5915
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JET-LIKE STRUCTURE OF K^-p and $\bar{p}p$ INTERACTIONS AT 32 GeV/s

Moscow YADERNAYA FIZIKA in Russian Vol 45, No 1, Jan 87
(manuscript received 20 Mar 86) pp 102-109

[Article by V. V. Badintsev, V. A. Bumazhnov, A. A. Minayenko, A. M. Moiseyev, and S. V. Chekulayev, Institute of High-Energy Physics, Serpukhov, A. S. Proskuyakov and L. I. Sarycheva, Scientific Research Institute of Nuclear Physics, Moscow State University, Moscow, U. Hentsch, Institute of High-Energy Physics, GDR Academy of Sciences, G. Mac-Notton and F. Mandl, Institute of High-Energy Physics, Austrian Academy of Sciences, Vienna Serpukhov-Moscow-Berlin-Vienna Collaboration]

[Abstract] Studies concerning the jet-like structure of finite hadron states produced in K^-p -collisions and $\bar{p}p$ -collisions at 32 GeV/s have yielded data in two collective variables: thrust and sphericity. These data are compared with those on e^+e^- -annihilation at similar energy levels for detection of an analogy. Experiments at the Institute of High-Energy Physics in Serpukhov were performed in the "Mirabel" chamber with separate K^- -meson and antiproton beams, each having a momentum of 32 GeV/s. After the variables have been defined, deviations from a two-jet structure are examined in terms of the mean-square momentum in the plane of the two intersecting axes and in the plane perpendicular to it. An analysis of the data reveals no essential difference between inclusive samples of diffractionless K^-p -collision events and $\bar{p}p$ -collision events at 32 GeV/s, but reveals a significant role of the leading particle. In the case of charged particles with low multiplicity $\bar{p}p$ -collisions are more jet-like than K^-p -collisions, evidently because an antiproton has a stronger leading effect than a K^- -meson. However, there have been recorded more lanar K^-p -interaction events at 32 GeV/s than K^+p -interaction events at 70 GeV/s. Comparison with e^+e^- -annihilation at similar energy levels reveals a stronger collimation of hadron-interaction jets. Figures 6; tables 1; references: 15 Western.

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DYNAMICS OF ION STORAGE PROCESSES IN ELECTRON BEAMS AND RINGS

Moscow FIZIKA ELEMENTARNYKH CHASTITS I ATOMNOGO YADRA in Russian Vol 18, No 1, Jan-Feb 87 pp 154-200

[Article by E. A. Perelshteyn and G. D. Shirkov, Joint Institute of Nuclear Research, Dubna]

[Abstract] Production and storage of ions in electron beams and rings are reviewed on the basis of research done since 1957 and especially in the past 12 years. Both ionization of neutral atoms and multiple ionization of ions by electron impact are considered, namely by an electron impinging on the target and interacting either with an electron in the outer shell (direct ionization) or with electrons in inner subshells (Auger ionization), the cross-section for ionization depending on the electron energy classically according to the Thompson law. Subsequent ion-ion and ion-atom interactions in an electron beam or ring are described by corresponding two equations of charge concentration kinetics and balance, the buildup of ions being calculated by solving the inverse problem of ionization most expediently on a computer. Recently developed ion sources are EBIS (Electron-Beam Ion Source), the KUTI (Collective Heavy-Ion Accelerator), and the KRION-2 (Kr and Xe Ion Source). Further analysis of electron-beam and ion-beam dynamics is generally based on the method of moments, using various proposed models and in the case of rings second-order moments. This method can be extended to multicomponent charged-particle beams. Storage of ions in electron-ion beams is limited by overcharge on the residual gas and neutralization of the latter in the accelerator chamber as well as by loss of ions upon their heating by electrons. Practical problems include storage of ions in long linear electron beams and in electron rings. The feasibility of producing and storing multiply charged ions in electron rings of a collective accelerator has been examined both theoretically and experimentally, successful experiments having been performed with special ion sources such as the ERIS (Electron-Ring Ion Source), the PIG (Penning Plasma-Arc Ion Generator), the DP (Dual Plasmatron), and the ECR (Electron-Cyclotron-Resonance Ion Source). Figures 18; tables 1; references 128: 93 Russian, 1 Bulgarian, 3 Yugoslav, 31 Western (2 in Russian translation).

2415/5915

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GLUON JETS IN HADRON-HADRON PROCESSES AND CONFINEMENT EFFECT

Moscow FIZIKA ELEMENTARNYKH CHASTITS I ATOMNOGO YADRA in Russian Vol 18,
No 1, Jan-Feb 87 pp 79-109

[Article by I. M. Dremin, Institute of Physics imeni P. N. Lebedev, USSR
Academy of Sciences, Moscow]

[Abstract] Strong interactions of particles are reviewed in the light of quantum chromodynamics theory, which treats hadrons as bags containing quarks and gluons but does not adequately describe experimental data on the final stage of hadronization, as well with use of phenomenological models which include confinement. Confinement of gluon jets by color currents is defined in terms of distance within the nucleus, essentially inelastic interactions being considered here and possible deconfinement of quarks along the path being taken into account. The cross-section for gluon production and then gluon emission is determined from the appropriate equation according to the theory of Fraunhofer diffraction at a slit of finite dimension, with color current represented as a "step" of length equal to the confinement distance, taking into account presence of a transition region and formation of ring event structures on the target diagram. Emission of electromagnetic radiation along finite path segments as manifestation of deconfinement is illustrated with thought experiments such as interaction of a quarkonium and a gluon condenser. Examples of radiation emission are its emission from gluon jets and from neutral jets, emission of Vavilov-Cherenkov radiation in thin plates, electron emission from an accelerator or from the gap of a split waveguide, electron emission in metals excited by electromagnetic waves, and photon emission by an electron scattered by two centers. Ring events have been revealed by data on cosmic rays and on acceleration of particles. It should be possible to predict on this basis various properties of quarks and gluons as well as some structural characteristics of hadrons in general. The author thanks Ye. L. Feynberg for valuable comments and B. M. Bolotovskiy for discussing several relevant problems of electrodynamics. Figures 8; references 53: 42 Russian, 11 Western (2 in Russian translation).

2415/5915

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CALCULATION OF MASS OF NUCLEONS IN VARIOUS GENERATIONS ACCORDING TO
THEORY OF GAUGE FIELDS

Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 29, No 12,
Dec 86 (manuscript received 31 Jul 84) pp 62-67

[Article by A. N. Kushnirenko, Kirovograd Pedagogical Institute imeni
A. S. Pushkin]

[Abstract] Existence of various generations of nucleons is proved by calculation of the nucleon mass as has been done earlier for leptons, considering that "exclusion" of all interactions will leave the prime mass of a nucleon. Calculations are based on the theory of gauge fields in the approximation of one ϕ_d -boson and in the zeroth approximation of the perturbation theory, with reference to the Heisenberg quasi-particle model of quarks rather than the inadequate here "bag" model of hadrons. Calculations for four generations of protons with corresponding quantum numbers subject to conservation in all processes, "charm" number characterizing second-generation particles and "beauty" number characterizing third-generation particles, are made without renormalization of mass and thus require truncation of divergent integrals until a better theory becomes available. The method is applicable to neutrons as well. References: 3 Russian.

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RADIATION FROM ELECTRONS IN SYNCHROTRON WITH RECTILINEAR GAPS

Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 29,
No 12, Dec 86 (manuscript received 16 Oct 84) pp 67-72

[Article by M. M. Nikitin and N. I. Fedosov, Tomsk Polytechnic Institute
imeni S. M. Kirov]

[Abstract] Synchrotron emission of energy by electrons moving through a cyclic accelerator with rectilinear gaps is analyzed, and its characteristics are evaluated on the basis of electron ballistics and radiation field theory. Electrons are assumed to move at a constant speed $V = \beta c$ (c - speed of light) along a plane circular trajectory of radius R split into four segments by rectilinear gaps of length $2a$. The angular distribution and then the spectral-angular distribution of energy emitted during N complete passes of an electron around the circle are calculated from the Landau-Lifshitz integro-differential equation, after the integral has been split into partial ones corresponding to circular and rectilinear segments of the accelerator structure. For the special case of ultrarelativistic electrons with the radiation frequency approaching infinity integrals are evaluated by asymptotic expansions. The results reveal

that a rectilinear gap in the synchrotron gives rise to an azimuthal asymmetry of the spectral-angular distribution of emitted energy, this asymmetry diminishing however as the radiation frequency increases and vanishing already at the frequency of the peak in the synchrotron spectrum. References 8: 6 Russian, 2 Western (both in Russian translation).

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TOPOLOGICALLY NONTRIVIAL LOOP MONOPOLES

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 45, No 1, 10 Jan 87 (manuscript received 23 Oct 86) pp 3-5

[Article by I. A. Ovidko, Leningrad Polytechnic Institute imeni M. I. Kalinin]

[Abstract] A new kind of topological excitations namely topologically non-trivial loop configurations of gauge fields, is described and analyzed in the formalism of stratified spaces constituting the geometrical analog of Yang-Mills-Higgs gauge theories. In order to classify loop monopoles, it is sufficient to calculate the set of stratification equivalence classes. This

problem reduces to homotopical classification of $L \rightarrow B_G$ and $R^3 \setminus L \rightarrow B_H$ maps

(L - toroidal region, B_G - base of universal G -stratification, B_H - base of universal H - stratification, R^3 - three-dimensional Euclidean space). Solution of this problem in accordance with the theory of obstacles yields a classification of loop monopoles into sets which are elements of the group

$\Gamma^0(G, H) = \pi_1(G, H) \times \pi_2(G, H)$ so that every loop monopole consists of a spherical monopole and a filiform configuration. It is further demonstrated that loop monopoles with continuous toroidal kernels, namely combinations of spherical monopoles and filaments, as well as loop monopoles with kernels containing spherical monopoles only are topologically stable configurations of gauge fields. Figures 2; references 6: 1 Russian, 5 Western (1 in Russian translation).

2415/5915
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ALGORITHMS AND NUMERICAL METHODS

STEADY SPREAD OF TREE-TOP UPPER-TIER FOREST FIRES

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 22, No 6, Nov-Dec 86
(manuscript received 9 Sep 85) pp 101-108

[Article by A. M. Grishin, V. G. Zverev, and S. V. Shevelev, Tomsk]

[Abstract] A steady spread of tree-top upper-tier forest fires is analyzed on the basis of a mathematical model which describes processes in an airy forest of infinite horizontal dimensions. The forest canopy of tree tops is assumed to constitute a chemically reacting nondeformable one-temperature multicomponent medium, its components being dry organic substance, water in liquid-drop state, condensed products of pyrolysis, mineral combustibles, and a gaseous phase, the latter containing oxygen, inert components of air, combustible and inert volatile products of pyrolysis of the mineral fraction. The corresponding system of two-dimensional equations describing spread of a fire with attendant heat and mass transfer in accordance with the laws of mass, energy, and momentum conservation is averaged over the forest height, considering that the height of a forest is much smaller than its horizontal dimensions. The resulting system of partial differential equations with appropriate initial and boundary conditions is first simplified by lumping all volatile products of pyrolysis into an equivalent gas, namely CO as the most representative one, and by assuming that the flow of air does not depend significantly on the combustion process so that the wind velocity becomes approximately uniform. The system of equations is then solved by the numerical method of finite differences according to an iteration-interpolation algorithm. This has been done using an approximate expression for the velocity of fire based on an analytical solution to the problem of flame front propagation in the steady-state approximation. Calculations on this basis have yielded the dynamics of tree-top upper-tier forest fires, including evolution of a steadily propagating fire front. Mathematical experiments have revealed that steady spread of such fires is possible only when the wind velocity remains within a certain range under constant other conditions. Both lower and upper limits of this range were determined in two ways: 1) by selecting a pair of wind velocities corresponding respectively to steady spread and abatement of fire, then finding the threshold velocity by successive divisions of the difference into half, 2) by gradually decreasing and increasing the wind velocity from some level corresponding to steady spread of fire. Figures 3; tables 1; references: 9 Russian.

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SOLVING LINEAR PROBLEM OF FAST RESPONSE BY NUMERICAL METHODS

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 15: VYCHISLITELNAYA
 MATEMATIKA I KIBERNETIKA in Russian No 4, Oct-Dec 86
 (manuscript received 29 May 85) pp 41-46

[Article by M. V. Orlov]

[Abstract] The linear control problem $\dot{x} = Ax + u$ (A - $n \times n$ -dimensional constant matrix) of moving an object from an initial state $x_0 \neq 0$ to the origin of coordinates in the minimum time can be solved on the basis of the maximum principle, which is the necessary and sufficient condition for optimality of control u . The problem accordingly reduces to a finite nonlinear system of equations, which can be solved by various numerical methods for the optimum control and trajectory. Two such methods are the Newton method and projection of the initial state onto the isochrone, the latter method reducing the problem to a special form of the Cauchy problem and involving the use of the Euler scheme. This scheme can be refined by solving the equation of the projection method by the Newton method with the appropriate zeroth-order initial approximation. The algorithm of such a solution of the original control problem is constructed on the basis of two convergence theorems, their proof not shown here because of its lengthiness. The algorithm has been programmed in FORTRAN for numerical experiments covering the $n = 2, 3, 4$ range of matrix- A dimensionality. The author thanks Yu. N. Kiselev. Tables 2; references: 4 Russian.

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METHODS OF TOPOLOGY IN COMBINATORIAL PROBLEMS

Moscow USPEKHI MATEMATICHESKIKH NAUK in Russian Vol 41, No 6(252), Nov-Dec 86
 (manuscript received 26 Nov 85) pp 37-48

[Article by S. A. Bogatyy, Moscow State University imeni M. V. Lomonosov]

[Abstract] Extension of topological methods to solution of combinatorial problems is demonstrated on the basis of Hadwiger and Kneser hypotheses following a Borsuk theorem about sets covering spheres. Four additional theorems are proved and the Fürstenberg-Weiss theorem is referred to, with eight corollaries between them. Four additional hypotheses are considered, one already proved and the others shown to be provable, which will facilitate involvement of topology with set theory and combinatorial number theory. References 35: 2 Russian, 1 Polish (in Russian translation), 32 Western (3 in Russian translation).

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SOME UNIVERSAL CONSTRAINTS ON ALGORITHMS OF CLASSIFICATION

Moscow ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian
Vol 26, No 11, Nov 86 (manuscript received 12 Apr 85) pp 1719-1730

[Article by K. V. Rudakov, Moscow]

[Abstract] The problem of constructing correct algorithms of classification is treated as a problem of constructing correct algebras over a set of heuristic incorrect algorithms. Specifically an algorithm is constructed which maps data from a set of possible initial information onto a set of possible final information, both sets being matrix spaces of arbitrary but fixed dimensions $q \times l$. After the basic concepts and properties relevant to classification problems have been established, constraints on such problems are defined in terms of a system consisting of one local constraint and universal supplementary ones. The latter are described in functional and symmetric $\Phi_0, \Phi_q, \Sigma_0, \Sigma_q$ of bases, whereupon regular classification problems are defined on the basis of a theorem and two corollaries provable with the aid of seven lemmas pertaining to those categories. References: 4 Russian.

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ADAPTATION IN STRUCTURAL PATTERN RECOGNITION

Moscow ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian
Vol 26, No 11, Nov 86 (manuscript received 12 Mar 85) pp 1695-1703

[Article by A. S. Dzyuba and V. I. Mishkin, Moscow]

[Abstract] Adaptive reconstruction of a syntax consisting of nontrivial symbols and generating structural objects represented by a matrix of graphical markers is examined using a modified approach, not analogously to minimization of the empirical risk but by polynomial algorithms of local optimization. An object is generally defined by n generating vertices, $v = (v_1, \dots, v_n)$ markers of vertices in space L_1 , and $\tilde{g} = \|\tilde{g}_{ij}\|_{n \times n}$ markers of edges in space L_2 . For illustration is considered a simple object with a fixed number of vertices n and $v = 0$, namely an oriented graph defined by a single matrix $\tilde{g} = \|\tilde{g}_{ij}\|_{n \times n}$ with elements $\tilde{g}_{ij} \in \{0, 1\}$ representing markers of edges which can have two values $L_2 \equiv \{0, 1\}$. The adaptation problem, reconstructing the grammar of a reference matrix from the set of objects generated by it, is first solved assuming no deformation of the objects. The solution is based on a theorem pertaining to

the necessary and sufficient condition for any other reference matrix to become isomorphous with the original one. Algorithms of efficient realization are analyzed for complexity and then extended to adaptation from a set of deformed objects, whereupon their convergence is established on the basis of a second theorem. References 7: 2 Russian, 5 Western (3 in Russian translation).

2415/5915

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MATHEMATICAL MODELS AND COMPUTER EXPERIMENT FOR PROBLEMS OF FUNCTION-SIGNAL RECONSTRUCTION FROM FINITE SET OF DATA

Moscow ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 26, No 11, Nov 86 (manuscript received 11 Mar 85, after revision 25 Dec 85) pp 1605-1616

[Article by Yu. A. Belov and V. S. Kasyanyuk, Kiev]

[Abstract] Tikhonov's method of regularizing improperly-conditioned problems with many possible solutions, for avoidance of instability, is applied to reconstruction of a function-signal from a finite set of data. A function-signal is defined as one in the class \mathcal{K} of functions describable in the form $f(z) = \int_Q g(z,t)u(t)dt$ ($z \in D$), with the complex functions $g(z,t)$ and $u(t)$ denoting respectively the kernel and the spectrum of a signal ($Q \subset E^n$, $D \subset E^n$, $u(t) \in L_2[Q]$, $g(z,t)$ continuous in $D \times Q$). The problem of reconstruction is formulated as one of finding the function $u(t)$ and thus $f(z)$ which will satisfy the equalities $\mathcal{X}_k(f) = y_k - v_k$ ($k = 1, 2, \dots, m$), where $\mathcal{X}_k(\cdot)$ are linear functionals defined in the class \mathcal{K} and $v = [v_1, \dots, v_m]^T$ is a random vector of noise with zero mean and known correlation matrix $R = M(vv^*)$. Several models are used for solving this problem, first pseudoinverse solution of the problem for the corresponding system of integral equations of moments without a priori information about the noise vector v . Various models are used for minimizing the effect of the noise component. They include expansion of the solution in an appropriate basis, formulation of the problem as an eigenvalue and eigenfunction problem, two-criterial optimization with a Pareto set as solution, and conditional extremum. The maximum-likelihood model is another one for solving the reconstruction problem. Figures 4; references 11: 8 Russian, 3 Western (1 in Russian translation).

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